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# EP/TOMS
# Science Data Processing

# Programmer's Guide

## Version 1.9

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Prepared by:

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# EP/TOMS Programmer's Guide
## Version History

| Version Number | Version Date | Comments |
|---|---|---|
| 0.0 | Sep. 30, 1997 | initial version |
| 1.0 | Oct. 31, 1998 | baseline version (replaces entire initial version) |
| 1.1 | Jan. 6, 1999 | installation of *cdtomsqc* 1.7 and *gridt* 2.9 (replacement pages M-2 and M-4) |
| 1.2 | Jun. 15, 1999 | updated to:<br>- reflect adaptive and Y2K changes in the TOMS processing file systems and software<br>- reflect changes in organizations and physical locations<br>- reflect the retirement of overpass and unitree software<br>- make documentation corrections and add clarifications<br>- expand description of the Calibration Subsystem<br>changed pages are ii to vi, 1 to 10, 12 to 17, 19 to 32, 34 to 37, 39 to 44, 46, 48, 50 to 56, 60, 62, 74, 76, 77, 78, 81, 83 to 90, 93 to 96, 103 to 107, 109 to 113, 116, 117, A-1, A-4, A-5, A-6, A-17, A-22 to A-47, B-1 to B-6, B-10, B-11, B-12, B-17, B-18, B-22 to B-28, B-30 to B-35, C-1, C-2, C-3, C-6 to C-12, D-1 to D-3, D-13 to D-16, D-20, D-21, D-27, D-28, D-29, D-33, D-34, E-2, E-3, E-4, F-6, F-8, F-10, F-12, F-15, H-6, H-11, I-1, I-4 to I-8, J-2, J-13, K-1, M-2, M-4, M-7, N-1, and N-2<br>deleted pages are K-2 through K-10<br>new pages are D-35 and D-36 |
| 1.3 | Sep. 15, 1999 | updated to:<br>- include daily and monthly level 3 zonal means s/w & data<br>- include level 3 monthly averages s/w & data<br>changed pages are ii, iii, iv, 2, 3, 6, 8, 9, 13, 14, 15, 16, 17, 29, 34, 44, 50, 53, 60, 64, 77, 78, 84, 103, 107, A-1, A-23, B-1, B-30, B-36, C-1, C-12, L-1, L-2, L-3, and M-1<br>new pages are 81a, B-9a, B-30a, B-30b, B-32a, L-1a, L-1b, L-1c, and M-8a |
| 1.4 | Dec. 15, 1999 | updated to:<br>- reflect changes in the TOMS processing system since last revision including:<br>1) level 3 zonal means and monthly average erythemal uv products<br>2) a bridge program to reformat dates in FDF EPHEM files<br>3) changes in process scheduling<br>changed pages are ii, iv, 2, 14, 15, 29, 33-35, 44-46, 48, 49, 77-81, 103, B-1, B-9a, B-30a, B-30b, B-32a, and E-1<br>new pages are 46a and E-3a |
| 1.5 | Mar. 15, 2000 | updated to begin to address GSFC comments<br>changed pages are ii, iv, 3, 5, 9, 10, 12, 17, 27-29, 42, 46, 76, 103, 108, A-1, A-2, A-6, A-18, A-22, A-39, A-42, B-1, B-6, B-10, B-25 to B-28, B-30, B-30b, B-31, B-33, B-36, C-1, C-9, D-1, D-3, D-14, D-16, D-20, D-27, D-29 to D-31, D-35, D-36, E-2 to E-4, E-8 to E-10, F-4, F-6, F-8, F-9, F-11 to F-13, F-15, F-17, F-19, F-21, G-2, H-2, H-4 to H-7, H-11, H-13 to H-15, H-18, H-19, I-2, I-3, I-8, J-1, J-9 to J-11, J-13, J-14, J-16 to J-18, J-21, J-22, J-24, L-1a, L-3, M-1, M-2, M-4, M-7, M-9, M-13, M-15, and O-1<br>new pages are A-4a and C-7a to C-7c |
| 1.6 | Jun. 15, 2000 | updated to:<br>- add FOV constants generation s/w<br>- remove zonal means aerosol files & file generation<br>- continue to address GSFC comments<br>changed pages are i-iv, vi, 2, 5, 9, 10, 13-18, 20, 21, 27, 28, 33-38, 40, 41, 44-46, 47, 62, 76, 80, 84, 89, 90, 92, 102, 106, A-1, A-4, A-42, B-1, B-9a, B-32a, C-1, C-8, C-11, E-1 to E-4, and E-7 to E-10<br>new pages are A-4b, A-44a, A-46a, B-32b, B-32c, and C-3a |
| 1.7 | Sep. 15, 2000 | updated to:<br>- document changes related to modifying Level 2 Standard Product File names<br>- continue to address GSFC comments<br>changed pages are: i, ii, iv, v, 9, 14, 15, 17, 36, 37, 39, 40, 42, 44, 47, 62-65, 67, 70, 76, 80, 81, 84, 85, 89, 90, 93, 94, D-1, D-3, D-35, F-1 to F-4, F-6 to F-13, F-15, F-17, F-19, F-21, J-17, and J-19 to J-23<br>new page is: D-35a<br>deleted page is: 81a |

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## Acronyms and Abbreviations

| | |
|---|---|
| ASCII | American Standard Code for Information Exchange |
| ADEOS | ADvanced Earth Observing Satellite (Japan) |
| DAAC | Distributed Active Archive Center |
| EP | Earth Probe |
| FDD | Flight Dynamics Division (GSFC) |
| FDF | Flight Dynamics Facility (GSFC) |
| GIF | Graphic Interchange Format |
| GSFC | Goddard Space Flight Center |
| HDF | Hierarchical Data Format |
| ICD | Interface Control Document |
| IDL | Interactive Data Language (Research Systems Inc.) |
| | Information Technology and Scientific Services |
| NASA | National Aeronautics and Space Administration |
| NOAA | National Oceanic and Atmospheric Administration |
| NORAD | North American Air Defense Command |
| ODS | Orbit Data Set (orbit table) |
| PS | PostScript |
| QC | Quality Control |
| SSAI | Science Systems and Applications, Inc. |
| RUF | Raw Units File |
| SGI | Silicon Graphics Inc. |
| $SO_2$ | Sulphur dioxide |
| SOC | Science Operations Center |
| TIA | Technical Interface Agreement |
| TMOC | TOMS Mission Operations Center (GSFC) |
| TOMS | Total Ozone mapping Spectrometer |
| UT | Universal Time |
| UV | UltraViolet |

# 1. Introduction

This Version 1.0 document should be considered a baseline. It will be updated quarterly to reflect future software modifications in the EP/TOMS processing system and computing environment, to add detail or expand document scope, and to correct errors. Please send comments regarding this version to:

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## 1.1 Overview

This EP/TOMS Programmer's Guide provides detailed information concerning the data, software, operations, and maintenance of the EP/TOMS Science Data Processing System. This system was developed for the NASA Goddard Space Flight Center (GSFC), Laboratory for Atmospheres, Atmospheric Chemistry Branch (Code 916) by SSAISTX Corporation.

The description of the EP/TOMS Science Data Processing System starts with an overall system perspective (Section 3). A description of all data files ingested, stored, and/or produced follows in Section 4. Detailed descriptions of each major software subsystem are in Section 5. Section 6 presents processing procedures. Section 7 presents maintenance procedures. Procedures for updating this document are included in Section 7.

The EP/TOMS Science Data Processing System consists of the file systems, software, data, and procedures used for:

- level 1-3 science processing
- process control
- processing and maintenance support

Approximately 100 FORTRAN, C, and IDL programs make up the EP/TOMS Science Data Processing System. Over 200 UNIX shell and Perl scripts control these programs. Table 1.1-1 lists the EP/TOMS science data processing items that are documented in this programmer's guide. Details of the items in this inventory are given in Sections 4 and 5.

Software and procedures for the following functions are not described in the current version of this document:

- calibration analysis
- science analysis
- instrument health and safety analysis
- level 0 science data processing
- data and algorithm validation
- ozone table generation

- fixed, auxiliary data generation

**Table 1.1-1**
**EP/TOMS Science Data Processing System Inventory[1]**

| Inventory Type | No. of Items | Location (*tparty.gsfc.nasa.gov*) |
|---|---|---|
| FORTRAN & C Programs for:<br>- ingest/QC<br>- product generation<br>- file QC<br>- process monitoring<br>- data maintenance | 62 programs | executables are stored in */uv/tprod/ep/bin/*<br>source code is stored in:<br>*/uv/tprod/ep/src/aux/* - generate or dump auxiliary data (1 program)<br>*/uv/tprod/ep/src/cal/* - initialize, generate, or dump calibration data (3 programs)<br>*/uv/tprod/ep/src/eph/* - ingest, reformat, QC, or dump spacecraft ephemeris data (7 programs)<br>*/uv/tprod/ep/src/include/* - FORTRAN common block definitions and C header files<br>*/uv/tprod/ep/src/ovp/* - generate overpass data (6 retired programs not included in #)<br>*/uv/tprod/ep/src/util* - general purpose programs (called throughout the system) (8 programs)<br>*/uv/tprod/ep/src/v0/* - ingest, QC, subset, or dump Level 0 data (12 programs)<br>*/uv/tprod/ep/src/v1/* - generate, QC, subset, or dump Level 1 data (10 programs)<br>*/uv/tprod/ep/src/v2/* - generate, QC, or dump Level 2 data (9 programs)<br>*/uv/tprod/ep/src/v3/* - generate, QC, or dump Level 3 data (8 programs)<br>*/uv/tprod/ep/src/zm/* - generate or dump zonal means data (4 programs) |
| Library Subprograms | 47 subprograms | */uv/tprod/ep/src/lib/* |
| IDL Programs | 388 programs | */uv/tprod/ep/cal/*, */uv/tprod/ep/src/aux/satfov/*, and */uv/tprod/ep/tool/* |
| UNIX Shell & Perl Scripts | 217 scripts | */uv/tprod/ep/bin/* and */uv/tprod/ep/tool/* |
| Input Data Files | 288 file types | */uv/tprod/ep/aux/* - auxiliary data files<br>*/uv/tprod/ep/v0i/* - instrument level 0 files<br>*/uv/tprod/ep/v0s/* - spacecraft level 0 files<br>*/uv/tprod/ep/nrt/v1/* - predictive spacecraft ephemeris files (UNIX format)<br>*/uv/tprod/ep/v1/* - definitive spacecraft ephemeris files (UNIX format)<br>*/uv/tprod/ep/zm/* - ozone climatology |

(continued on next page)

[1] these items are resident on GSFC Code 916 computers and are documented in the "EP/TOMS Science Data Processing Programmer's Guide".

**Table 1.1-1** (continued from previous page)

## EP/TOMS Science Data Processing System Inventory

| Inventory Type | No. of Items | Location (*tparty.gsfc.nasa.gov*) |
|---|---|---|
| Intermediate Data Files | 12 file types | */uv/tprod/ep/nrt/v0ib* - orbital instrument level 0 files (predictive)<br>*/uv/tprod/ep/cal/* - intervention products (4 file types)<br>*/uv/tprod/ep/ovp/ovpda/* - obsolete overpass direct access files (not incl. in # of items)<br>*/uv/tprod/ep/v0ib* - orbital instrument level 0 files (definitive)<br>*/uv/tprod/ep/v0s/sub/* - spacecraft subset files<br>*/uv/tprod/ep/v1sub/* - level 1 subset files (4 file types)<br>*/uv/tprod/ep/zm/* - zonal means statistics files (2 file types) |
| Product Data Files | 14 file types | */app/ftptoms/pub/eptoms/data/monthly_averages/* - level 3 monthly averages files<br>*/uv/tprod/ep/nrt/v1/* - near real-time level 1 files<br>*/uv/tprod/ep/v1/* - definitive level 1 files<br>*/uv/tprod/ep/nrt/v2/* - near real-time orbital level 2 (native) files<br>*/uv/tprod/ep/nrt/v2d/* - near real-time daily level 2 (native) files<br>*/uv/tprod/ep/v2/* - definitive orbital level 2 (native) files<br>*/uv/tprod/ep/v2d/* - definitive daily level 2 (native) files<br>*/uv/tprod/ep/v2hdf/* - standard level 2 (HDF) files<br>*/uv/tprod/ep/v2/* - definitive orbital level 2 (native) files<br>*/uv/tprod/ep/nrt/v3/* - near real-time level 3 (ASCII) files<br>*/uv/tprod/ep/nrt/v3map/* - monthly level 3 image files<br>*/uv/tprod/ep/v3hdf/* - standard level 3 (HDF) files<br>*/uv/tprod/ep/ovp/*- obsolete overpass files (not included in # of items)<br>*/uv/tprod/ep/zm/* - zonal means files (3 file types) |
| Processing History Files | 10 file types | */uv/tprod/ep/memo/* - processing and data backup logs<br>*/uv/tprod/ep/db/* - databases<br>*/uv/tprod/ep/nrt/v1/rpt/* - near real-time Level 1 file generation reports<br>*/uv/tprod/ep/nrt/v2/rpt/* - near real-time Level 2 file generation reports<br>*/uv/tprod/ep/nrt/v3/rpt/* - near real-time Level 3 file generation reports |

## 1.2 EP/TOMS Mission Summary

EP/TOMS is a polar orbiting satellite that was launched into a 500 km sun synchronous orbit on July 2, 1996. EP/TOMS was raised to a 740 km orbit in December 1997. This is the third in a series of 5 TOMS missions that started with Nimbus-7 in 1978 and will extend into the 21st century with the planned QuikTOMS~~Meteor-3M~~ mission in 2000.

EP/TOMS observes backscattered UV radiation at wavelengths suitable for measuring total ozone and effective surface reflectivity and can detect the presence of $SO_2$ and aerosols such as smoke and dust in the atmosphere.

The EP/TOMS has several observation and calibration modes. During the daytime portion of its orbit it normally scans the Earth through 35 distinct scenes; however, it can be commanded to "stare" at a fixed scan position. This "stare" mode was used on selected scans in April - June 1997. Solar calibrations are normally taken every orbit as the spacecraft moves from day to night. Other calibrations are performed on a regular schedule during the nighttime portion of the orbit. At other times the instrument is put into Standby mode.

The first EP/TOMS Earth scan data were observed during orbit 216 on July 16, 1996. Normal science operations began during orbit 339 on July 24, 1996. Orbits prior to 7902 (December 4, 1997) were at the lower 500 km orbit. Science operations at the 740 km orbit began with orbit 8038 on December 12, 1997.

# 2. Related Documentation

Description of major data sources may be found in:

"TOMS-EP ICD Between the TMOC/EP and the TOMS-EP Science Operations Center (Laboratory for Atmospheres/Code 910)", March 1994

"Interface Control Document Between the TOMS-EP Project and the Flight Dynamics Facility (FDF) for Support of the TOMS-EP Mission", July 1993

"Flight Dynamics Division (FDD) Generic Data Product Formats Interface Control Document (ICD)", June 1991

Descriptions of science algorithms, instrument performance, data quality assessment, and standard data products may be found in:

"Earth Probe Total Ozone Mapping Spectrometer (TOMS) Data Products User's Guide", NASA Reference Publication, 1998

"TOMS/Earth Probe Calibration: Low Orbit Period", RSTX Document #RSTX-3036-701-GJ-98-5, March 1998

"TOMRAD Radiative Transfer Program User's Guide", Z. Ahmad, October 1997

"TOMS/Earth Probe Year 1 Calibration Status", September 1997

"The Version 7 TOMS Algorithm as Applied to Nimbus-7/TOMS", HSTX Document #HSTX-3036-503-CS-96-017, June 1996

"Final Report on Nimbus-7 TOMS V7 Calibration", NASA Contractor Report 4717, March 1996

"Nimbus-7 TOMS Wavelength Scale Adjustments", HSTX Document #HSTX-3036-212-MD-94-007, June 1994

"Estimated Error in Nimbus-7 TOMS and SBUV Total Ozone", HSTX Document #HSTX-3036-108-CS-93-005, January 1993

Information concerning data customers may be found in:

"TIA with NOAA"

"Memorandum of Understanding (MOU) Between the EP/TOMS Science Operations Center (SOC) and the Goddard Distributed Active Archive Center (DAAC) for Data Archival and Distribution Support of EP/TOMS Science Data Products"

# 3. EP/TOMS Science Operations

EP/TOMS science data processing is performed at the EP/TOMS Science Operations Center (SOC) located at GSFC Code 916. The EP/TOMS SOC has several external data sources and data product customers. As shown in Figure 3-1 data sources include GSFC's TOMS Mission Operations Center (TMOC) and Flight Dynamics Facility (FDF).

TMOC provides instrument and spacecraft data on a playback by playback basis. Playback data are pushed in near real-time via electronic file transfer from GSFC Bldg 32 to the TOMS science processing workstation (*tparty.gsfc.nasa.gov*) in GSFC Bldg 33.

FDF provides predictive and definitive spacecraft position and velocity at even minute intervals. These spacecraft ephemeris data are also delivered via electronic file transfer (push) to the '*tparty*' workstation.

EP/TOMS Level 3 global gridded and zonal mean data and images are distributed to the Internet community on a near real-time basis. Internet access is through the TOMS Web site (*http://toms.gsfc.nasa.gov*) or through anonymous ftp login to *toms.gsfc.nasa.gov*.

Standard Level 2 and Level 3 products are archived in HDF format at the GSFC Distributed Active Archive Center (DAAC). Product files are pulled from '*tparty*' to the DAAC whenever standard product ready notifications are received. These notifications are sent to the DAAC as e-mail.

At the time of this writing NOAA/NESDIS is processing EP/TOMS instrument data through Level 1 and Level 2 in a demonstration mode for their volcano hazards activity. Copies of quality checked instrument level 0 files, spacecraft ephemeris files, orbit table files, and near real-time Level 2 (native format) files are made available to NOAA (ftp-pull) for this purpose. These files are placed in NOAA accessible directories (i.e. *tparty:/home/georges*/ and *tparty:/home/farquhar*/) in near real-time. Copies of predictive Albedo Correction Files are also provided to NOAA on a weekly basis.

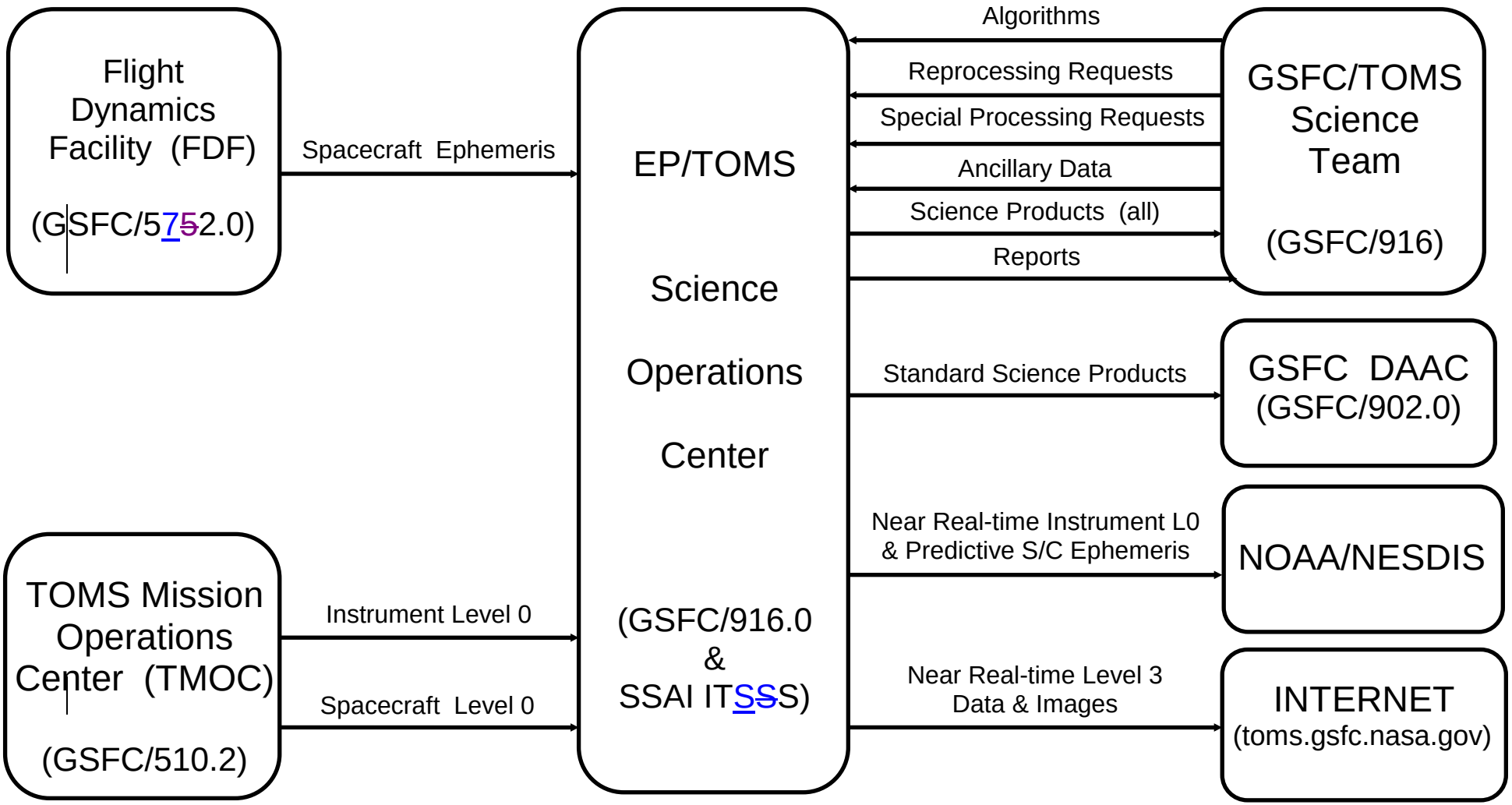
## 3.1 Processing Scenarios

The EP/TOMS serves operational and research users in monitoring current conditions, trending long term changes, and developing new products. To achieve these goals the EP/TOMS science data processing software serves multiple processing scenarios.

**Near Real-time Processing**

In the near real-time processing scenario data are processed as soon as received using predictive spacecraft ephemeris and predictive calibration. Near real-time processing and distribution of Level 3 data and images are performed automatically. The presence of new data triggers the processing of those data. Successful completion of the processing triggers product distribution. These near real-time data are identified as preliminary. They are, for example, suitable for tracking the location and geographical extent of ozone hole development. In the event of a failure of the automated processing, an operator menu interface is used for manual recovery.

**Figure 3-1**
**EP/TOMS Science Processing Context Diagram**



**Product Redo**

Product redo may be necessary from time to time to replace files that may be lost, damaged or incorrect due to some procedural or hardware problem. The original processing software and ancillary data are used for product redo. Product redo is initiated using the operator's menu interface.

**Reprocessing**

Reprocessing is when a dataset is recreated using a new algorithm or new calibration to produce original, or modified, data products. Typically reprocessing is performed on a long time series of data and may result in the production of standard products for the data archive. Reprocessing is initiated using the operator menu interface.

**Special Processing**

Other processing may be required from time to time to test new algorithms or to produce samples of new products. Special processing typically uses a set of known inputs that may be some subset of the inputs to normal science data processing. Special processing is performed separate from routine processing and the output files are isolated from routine processing products. A separate copy of the operator menu interface may be configured in the special processing environment to facilitate, and control, a special processing.

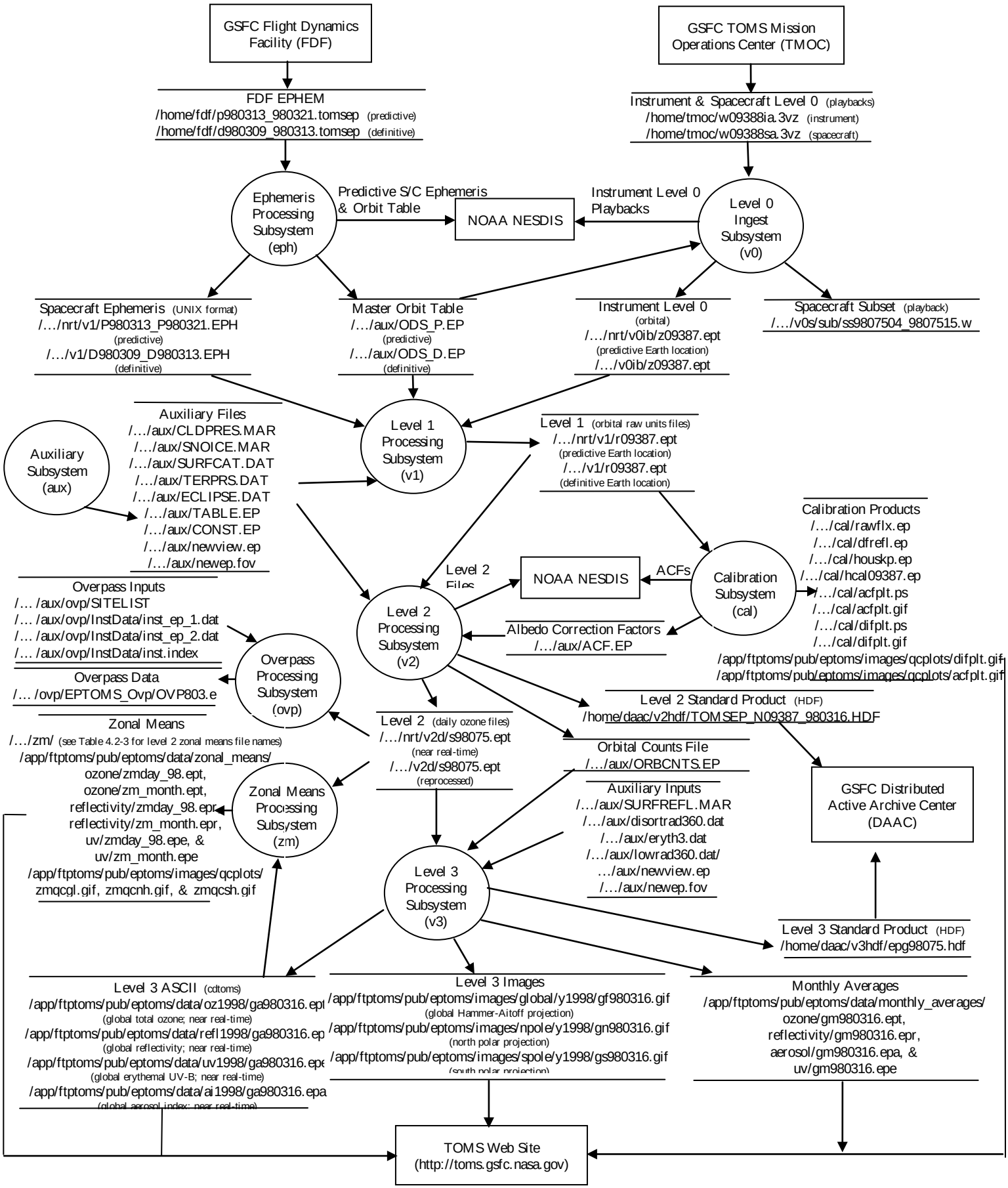
## 3.2 Science Data Processing System

Figure 3.2-1 shows the flow of data through the EP/TOMS Science Data Processing System. Organizations that provide data to, or receive products from, the EP/TOMS Science Operations Center are indicated in rectangles. Data stores are shown using parallel horizontal lines bordering text that gives data type names and sample file names. Each processing subsystem is shown as a circle in Figure 3.2-1. Each circle is labeled with the subsystem name and abbreviation.

Subsystems that process externally supplied input data are the Ephemeris Processing Subsystem for FDF's spacecraft ephemeris (EPHEM) data and the Level 0 Ingest Subsystem for TMOC's Instrument and Spacecraft Level 0 data. These subsystems also provide near real-time data to NOAA NESDIS as shown by the annotation on the data flow arrows.

The Calibration Subsystem also provides data for near real-time processing at NOAA NESDIS. Other subsystems that provide data products to external customers are the Level 2 Processing Subsystem and the Level 3 Processing Subsystem. Level 2 and Level 3 processing subsystems' standard products are archived at the GSFC DAAC. Data and image products from the Level 3 Processing Subsystem and the Zonal Means Processing Subsystem are provided to the TOMS Web Site (*http://toms.gsfc.nasa.gov*).

# Figure 3.2-1
# EP/TOMS Science Data Processing System




NOTE: substitute "/uv/tprod/ep/" for "/.../" in file names

Each data store shown in Figure 3.2-1 is described in Section 4. Data interfaces between programs that comprise each subsystem are also described. Subsystem software is described in Section 5.

## 3.3 Computing Environment

EP/TOMS science data processing is performed on 2 SGI workstations, "*tparty.gsfc,nasa.gov*" and "*wrabbit.gsfc.nasa.gov*". Both workstations are located in GSFC Bldg. 33. "*tparty*" is the primary TOMS processing computer; "*wrabbit*" is a backup. Other Code 916 resources are used as necessary for disk cache and for long term data storage. An offsite SGI workstation serves as an isolated development environment.

The TOMS science data processing systems are located in the *tparty:/uv/tprod/* file system. Subdirectories are present for each of the TOMS flights: Nimbus-7 (*n7*), Meteor-3 (*m3*), EP/TOMS (*ep*), and ADEOS (*a1*). All data and software described in this programmer's guide are located in */uv/tprod/ep/* except as noted.

EP/TOMS related data files are stored in the following subdirectories:

- */uv/tprod/ep/aux/* - auxiliary files [directory shared with n7, m3, and a1]
- */uv/tprod/ep/cal/* - calibration data
- */uv/tprod/ep/db/* - operations and product inventory databases
- */uv/tprod/ep/memo/* - processing history
- */uv/tprod/ep/nrt/* - predictive S/C ephemeris & near real-time data & products
- */uv/tprod/ep/ovp/* - overpass products
- */uv/tprod/ep/tle/* - 2 line elements (not currently used)
- */uv/tprod/ep/tmp/* - temporary files
- */uv/tprod/ep/v0/* - playback Level 0 Files (before QC)
- */uv/tprod/ep/v0i/* - playback Instrument Level 0 Files (after QC)
- */uv/tprod/ep/v0ib/* - orbital Instrument Level 0 Files
- */uv/tprod/ep/v0s/* - playback Spacecraft Level 0 Files (after QC)
- */uv/tprod/ep/v1/* - definitive S/C ephemeris & level 1 files (future reprocessing)
- */uv/tprod/ep/v1sub/* - subsets of level 1 files
- */uv/tprod/ep/v2/* - level 2 files (future reprocessing)
- */uv/tprod/ep/v2d/* - daily level 2 files (future reprocessing)
- */uv/tprod/ep/v2hdf/* - level 2 standard (HDF) product files
- */uv/tprod/ep/v3/* - level 3 files (future reprocessing)
- */uv/tprod/ep/v3hdf/* - level 3 standard (HDF) product files
- */uv/tprod/ep/zm/* - zonal means products

Section 4 provides descriptions of data stored in these 20 subdirectories.

The following subdirectories of the EP/TOMS data processing file system contain software:

- */uv/tprod/ep/bin/* - shell, FORTRAN, and C executables
- */uv/tprod/ep/src/* - FORTRAN, ~~and~~ C, & IDL (auxillary file generation) source code

- */uv/tprod/ep/tool/* - product validation & image generation tools (shell and IDL source code)

Section 5 provides descriptions of the software stored in these 3 subdirectories.

In general the *tomsprod* user owns the files contained in these directories, the *tomsprod* group has permission to read and write and execute, and all others have permission to read. Exceptions are as follows:

- */uv/tprod/ep/src/* is owned by the user *tomsmgr* the *swtoms* group (i.e. *batluck, herman, byerly, cgw, and mcpeters*) has read and execute permission
- only the *tomsprod* user can write into */uv/tprod/ep/aux/*
- file initialization and file generation executables contained in */uv/tprod/ep/bin/* can only be executed by the *tomsprod* user
- all others have permission to execute the IDL display codes in */uv/tprod/ep/tool/*

Table 3.3-1 shows the relationship of the EP/TOMS file system to the GSFC Code 916 UNIX cluster file system. The local '*tparty*' path is mapped to full and abbreviated cluster paths. This table is accurate as of the date indicated. Cluster paths may change from time to time.

# Table 3.3-1
## EP/TOMS Science Data Processing File Systems
(arranged alphabetically according to local 'tparty' path)

| Local 'tparty' Path | Content | Full Cluster Path | Abbreviated Cluster Path |
|---|---|---|---|
| /uv/tprod/ep/aux/ | Auxiliary data | /amd/tparty/vol/frenchhorn/misc/uvproc_6/aux/ | /misc/uvproc_6/aux/ |
| /uv/tprod/ep/bin/ | shell, FORTRAN, C exe | /amd/tparty/vol/frenchhorn/misc/uvproc_6/ep/bin/ | /misc/uvproc_6/ep/bin/ |
| /uv/tprod/ep/cal/ | calibration data | /amd/tparty/vol/cornet/misc/uvproc_2/ep/cal/ | /misc/uvproc_2/ep/cal/ |
| /uv/tprod/ep/db/ | Databases | /amd/tparty/vol/frenchhorn/misc/uvproc_6/ep/db/ | /misc/uvproc_6/ep/db/ |
| /uv/tprod/ep/memo/ | processing history | /amd/tparty/vol/frenchhorn/misc/uvproc_6/ep/memo/ | /misc/uvproc_6/ep/memo/ |
| /uv/tprod/ep/nrt/v0ib/ | nrt orbital inst L0 | /amd/tparty/vol/celeste/misc/uvproc_1/ep/nrt/v0ib/ | /misc/uvproc_1/ep/nrt/v0ib/ |
| /uv/tprod/ep/nrt/v1/ | nrt L1 | /amd/tparty/vol/dulcimer/misc/uvproc_4/ep/nrtv1/ | /misc/uvproc_4/ep/nrtv1/ |
| /uv/tprod/ep/nrt/v2/ | nrt orbital L2 | /amd/tparty/vol/cymbal/misc/uvproc_3/ep/nrtv2/ | /misc/uvproc_3/ep/nrtv2/ |
| /uv/tprod/ep/nrt/v2d/ | nrt daily L2 | /amd/tparty/vol/cymbal/misc/uvproc_3/ep/nrtv2d/ | /misc/uvproc_3/ep/nrtv2d/ |
| /uv/tprod/ep/nrt/v3/ | nrt L3 data | /amd/tparty/vol/celeste/misc/uvproc_1/ep/nrt/v3/ | /misc/uvproc_1/ep/nrt/v3/ |
| /uv/tprod/ep/nrt/v3map/ | nrt L3 images | /amd/tparty/vol/celeste/misc/uvproc_1/ep/nrt/v3map/ | /misc/uvproc_1/ep/nrt/v3map/ |
| /uv/tprod/ep/ovp/ | overpass data | /amd/tparty/vol/englishhorn/misc/uvproc_5/ep/ovp/ | /misc/uvproc_5/ep/ovp/ |
| /uv/tprod/ep/src/ | FORTRAN & C source | N.A. ('*tparty*' system disk) | N.A. |
| /uv/tprod/ep/tle/ | 2 line elements | /amd/tparty/vol/frenchhorn/misc/uvproc_6/ep/tle/ | /misc/uvproc_6/ep/tle/ |
| /uv/tprod/ep/tmp/ | Temporary files | /amd/tparty/vol/frenchhorn/misc/uvproc_6/ep/tmp/ | /misc/uvproc_6/ep/tmp/ |
| /uv/tprod/ep/tool/ | Val. & image tools | /amd/tparty/vol/frenchhorn/misc/uvproc_6/tool/ | /misc/uvproc_6/tool/ |
| /uv/tprod/ep/v0/ | playback L0 (temp) | /amd/tparty/vol/celeste/misc/uvproc_1/ep/v0/ | /misc/uvproc_1/ep/v0/ |
| /uv/tprod/ep/v0i/ | playback inst L0 | /amd/tparty/vol/celeste/misc/uvproc_1/ep/v0i/ | /misc/uvproc_1/ep/v0i/ |
| /uv/tprod/ep/v0ib/ | orbital inst L0 | /amd/tparty/vol/celeste/misc/uvproc_1/ep/v0ib/ | /misc/uvproc_1/ep/v0ib/ |
| /uv/tprod/ep/v0s/ | playback S/C L0 | /amd/tparty/vol/dulcimer/misc/uvproc_4/ep/v0s/ | /misc/uvproc_4/ep/v0s/ |
| /uv/tprod/ep/v0s/sub | S/C L0 subsets | /amd/tparty/vol/dulcimer/misc/uvproc_4/ep/v0s/aub | /misc/uvproc_4/ep/v0s/sub |
| /uv/tprod/ep/v1/ | def L1 | /amd/tparty/vol/dulcimer/misc/uvproc_4/ep/v1/ | /misc/uvproc_4/ep/v1/ |
| /uv/tprod/ep/v1sub/ | L1 subsets | /amd/tparty/vol/lira/misc/uvdat5/ep/v1sub/ | /misc/uvdat5/ep/v1sub/ |
| /uv/tprod/ep/v2/ | def orbital L2 | /amd/tparty/vol/cymbal/misc/uvproc_3/ep/v2/ | /misc/uvproc_3/ep/v2/ |
| /uv/tprod/ep/v2hdf/ | std (HDF) L2 | /amd/mhatter/vol/coconut/science/toms/production/data/ep/ | /science/toms/production/data/ep/L2HDF |
| /uv/tprod/ep/v2d/ | def daily L2 | /amd/tparty/vol/cymbal/misc/uvproc_3/ep/v2d/ | /misc/uvproc_3/ep/v2d/ |
| /uv/tprod/ep/v3/ | def L3 | /amd/tparty/vol/celeste/misc/uvproc_1/ep/v3/ | /misc/uvproc_1/ep/v3/ |
| /uv/tprod/ep/v3hdf/ | std (HDF) L3 | /amd/mhatter/vol/claves/misc/mhdat5/ep/v3hdf/ | /misc/mhdat5/ep/v3hdf/ |
| /uv/tprod/ep/zm/ | L2 & L3 zonal means | /amd/tparty/vol/englishhorn/misc/uvproc_5/ep/zm/ | /misc/uvproc_5/ep/zm/ |
| | | | |

NOTE: "nrt" denotes near real-time
"L0", "L1", "L2", and "L3" denote product levels 0, 1, 2, and 3
"inst" is an abbreviation for instrument
"def" denotes that definitive ephemeris was used for processing

# 4. Data Description

## 4.1 Data Types

There are more than 40 types of data files used in the EP/TOMS Science Data Processing System. Each can be assigned to one of four data categories; 1) system inputs, 2) data products, 3) intermediate data, or 4) processing history. An inventory of data types is given in Table 4.1-1.

**System Inputs**

System inputs include the following data types:

- albedo corrections
- instrument level 0 (playback)
- level 2 processing parameters
- level 3 processing parameters
- ozone retrieval parameters
- solar eclipse parameters
- spacecraft ephemeris (FDF EPHEM)
- spacecraft level 0 (playback)
- system setup parameters
- zonal means processing parameters

The following system input data types are reference data that are fixed, normally for the entire production run:

- cloud height climatology
- erythemal exposure and radiance tables
- fov constants
- level 2 file description metadata
- level 3 file description metadata
- ozone climatologies
- ozone table
- snow/ice cover
- surface category code
- surface reflectivity climatology
- terrain height
- view angles

These inputs are provided by external data sources, the GSFC TOMS Science Team, reference documents, or through setup processes. Each of these system inputs (except the erythemal exposure and radiance tables) is described in detail in Appendix A. Included in Appendix A is information pertaining to content, processing schedule, data volume, format, location, and file naming convention. Software that reads and writes each data type is also listed in Appendix A. The erythemal exposure and radiance tables are described in Appendix O.

Data Products

EP/TOMS science data products include those files that are distributed to the Internet or NOAA NESDIS and/or archived at the GSFC DAAC. Also included are those data files that are produced as part of the production pipeline and used internally by the GSFC TOMS Science Team to validate the data and the processing algorithms. EP/TOMS data product types are:

- calibration products
- daily level 2 file
- daily level 3 zonal means
- level 1 raw units file (RUF)
- level 2 (native) file
- level 2 standard product (HDF)
- level 2 zonal means
- level 3 ASCII file
- level 3 image products
- level 3 monthly averages
- level 3 standard product (HDF)
- monthly level 3 zonal means
- orbit table
- spacecraft ephemeris (UNIX format)
- spacecraft subset

## Table 4.1-1
## Data Inventory

| Name | Type | Directory | Sample File Name |
|---|---|---|---|
| Albedo Corrections | system inputs | /uv/tprod/ep/aux/ | ACF.EP |
| Backup Logs | processing history | /uv/tprod/ep/memo/<br><br>/uv/tprod/ep/memo/ar_tape/ | backup_eph.log, backup_vzi.log, backup_vzss.log<br>EPH_D, EPH_P, hdf, io, ip, sc, v1, v1rpt |
| Calibration History | intermediate data | /uv/tprod/ep/v1sub/ | rufcal_his.ep |
| Calibration Products | data products | /uv/tprod/ep/cal/ | rawflx.ep, dfrefl.ep, houskp.ep, hcal11430.ep, acfplt.ps, difplt.ps, acfplt.gif, difplt.gif |
| Cloud Height Climatology | system inputs | /uv/tprod/ep/aux/ | CLDPRES.JAN |
| Daily Level 2 File | data products | /uv/tprod/ep/nrt/v2d/<br>/uv/tprod/ep/v2d/ | s98230.ept |
| Daily Level 3 Zonal Means File | data products | /uv/tprod/ep/zm/ | zmday_98.ept, zmday_98.epr, zmday_98.epe |
| Ephemeris QC Parameters | intermediate data | /tmp/ (not retained) | ephqcp12345 (assuming that 12345 is PID) |
| Ephemeris Reformatting Parameters | intermediate data | /tmp/ (not retained) | reblk.12345 (assuming that 12345 is PID) |
| Erythermal Exposure and Radiance Tables | system inputs | /uv/tprod/ep/aux/ | eryth3.dat, disortrad360.dat, lowrad360.dat |
| FOV Constants | system inputs | /uv/tprod/ep/aux/ | newep.fov |
| Housekeeping History | intermediate data | /uv/tprod/ep/v1sub/ | rufhk_his.ep |
| Instrument Level 0 (playback) | system inputs | /home/tmoc/<br>/home/tmoc/reject/<br>/uv/tprod/ep/v0i/ | w11613iz.3vz<br><br>i9822905_9822916.w |
| Instrument Status History | intermediate data | /uv/tprod/ep/v1sub/ | rufinst_his.ep |
| Level 1 Processing Statistics | processing history | /uv/tprod/ep/v1sub/ | rufabs_his.ep |
| Level 1 Raw Units File (RUF) | data products | /uv/tprod/ep/nrt/v1/<br>/uv/tprod/ep/v1/ | r11613.ept |
| Level 1 Report File | processing history | /uv/tprod/ep/nrt/v1/rpt/<br>/uv/tprod/ep/v1/rpt/ | r11613.rpt |
| Level 2 File Description Metadata | system inputs | /uv/tprod/ep/aux/ | v2hdf_toms.ep |
| Level 2 (native) File | data products | /uv/tprod/ep/nrt/v2/<br>/uv/tprod/ep/v2/ | s11613.ept |

(continued on next page)

**Table 4.1-1** (continued from previous page)

**Data Inventory**

| Name | Type | Directory | Sample File Name |
|---|---|---|---|
| Level 2 Processing Parameters | system inputs | /tmp/ (not retained) | ozt9822912345 |
| Level 2 Report Files | processing history | /uv/tprod/ep/nrt/v2/rpt/<br>/uv/tprod/ep/v2/rpt/ | s98229_11613.rpt |
| Level 2 Standard Product (HDF) | data products | /home/daac/v2hdf/ & /uv/tprod/ep/v2hdf/ | TOMSEP_Neps15554_990517.HDFhdf |
| Level 3 ASCII File | data products | /uv/tprod/ep/nrt/v3/oz/yYYYY/<br>/app/ftptoms/pub/eptoms/data/ozYYYY/<br>/uv/tprod/ep/nrt/v3/ref/yYYYY/<br>/app/ftptoms/pub/eptoms/data/reflYYYY/<br>/uv/tprod/ep/nrt/v3/ery/yYYYY/<br>/app/ftptoms/pub/eptoms/data/eryYYYY/<br>/uv/tprod/ep/nrt/v3/res/yYYYY/<br>/app/ftptoms/pub/eptoms/data/aiYYYY/<br>where YYYY is year | ga980817.ept<br><br>ga980817.epr<br><br>ga980817.epe<br><br>ga980817.epa |
| Level 3 File Description Metadata | system inputs | /uv/tprod/ep/aux/ | v3hdf_toms.ep |
| Level 3 Image Products | data products | /app/ftptoms/pub/eptoms/images/global/<br>/app/ftptoms/pub/eptoms/images/npole/<br>/app/ftptoms/pub/eptoms/images/spole/ | gf980817.gif<br>gn980817.gif<br>gs980817.gif |
| Level 3 Monthly Averages | data products | /app/ftptoms/pub/eptoms/data/monthly_averages/ozone/, /reflectivity/, /aerosol/ | gm9808.ept, gm9808.epr,<br>gm9808.epa, gm9808.epe |
| Level 3 Processing Parameters | system inputs | /uv/tprod/ep/bin/ | gridprm |
| Level 3 Report Files | processing history | /uv/tprod/ep/nrt/v3/rpt/<br>/uv/tprod/ep/v3/rpt/ | g980817.rpt1 |
| Level 3 Standard Product (HDF) | data products | /home/daac/v3hdf/ & /uv/tprod/ep/v3hdf/ | epg98229.hdf |
| Local Equator Crossing History | intermediate data | /uv/tprod/ep/v1sub/ | ruflect_his.ep |
| Master Orbit Data Set (ODS) | intermediate data | /uv/tprod/ep/aux/ | ODS_D.EP |
| Monthly Level 3 Zonal Means | data products | /uv/tprod/ep/zm/ | zm_month.ept,<br>zm_month.epr,<br>zm_month.epe |
| Near Real-time Processing Report | processing history | /uv/tprod/ep/memo/mail/ | w11613sz.3vz |
| Orbit Table | data products | /uv/tprod/ep/nrt/v1/<br>/uv/tprod/ep/v1/ | P980814_P980822.ODS<br>D980810_D980814.ODS |

(continued on next page)

**Table 4.1-1** (continued from previous page)

**Data Inventory**

| Name | Type | Directory | Sample File Name |
|---|---|---|---|
| Orbit Database | processing history | /uv/tprod/ep/db/ | EP_ORB_DB |
| Orbital Counts | processing history | /uv/tprod/ep/aux/ | ORBCNTS.EP |
| Orbital Instrument Level 0 | intermediate data | /uv/tprod/ep/nrt/v0i/<br>/uv/tprod/ep/v0ib/ | z11613.ept |
| Ozone Climatologies | system inputs | /uv/tprod/ep/zm/ | zmday_clim.n7t,<br>minmax_clim.n7t |
| Ozone Retrieval Parameters | system inputs | /uv/tprod/ep/aux/ | CONST.EP |
| Ozone Table | system inputs | /uv/tprod/ep/aux/ | TABLE.EP |
| Playback History | processing history | /uv/tprod/ep/memo/ | prohis |
| Playback Inventory | processing history | /uv/tprod/ep/memo/ | playback |
| Snow/Ice Cover | system inputs | /uv/tprod/ep/aux/ | SNOICE.JAN |
| Solar Eclipse Parameters | system inputs | /uv/tprod/ep/aux/ | ECLIPSE.DAT |
| Spacecraft Ephemeris (FDF EPHEM) | system inputs | /home/fdf/<br>/home/fdf/reject/ | N/A |
| Spacecraft Ephemeris (UNIX Format) | data products | /uv/tprod/ep/nrt/v1/<br>/uv/tprod/ep/v1/ | P980814_P980822.EPH<br>D980810_D980814.EPH |
| Spacecraft Level 0 (playback) | system inputs | /home/tmoc/<br>/home/tmoc/reject/<br>/uv/tprod/ep/v0s/ | w11613sz.3vz<br><br>s9822905_9822916.w |
| Spacecraft Subset | data product | /uv/tprod/ep/v0s/sub/ | ss9822905_9822916.w |
| Spacecraft Subset Log | processing history | /uv/tprod/ep/memo/ | v0ss.log |
| Standard Product Inventory | processing history | /uv/tprod/ep/db/ | EP_PROD_DB |
| Surface Category Code | system inputs | /uv/tprod/ep/aux/ | SURFCAT.DAT |
| Surface Reflectivity Climatology | system inputs | /uv/tprod/ep/aux/ | SURFREL.JAN |
| System Setup Parameters | system inputs | /uv/tprod/ep/aux/ | toms_setup.ep |
| Terrain Height | system inputs | /uv/tprod/ep/aux/ | TERPRS.DAT |
| View Angles | system inputs | /uv/tprod/ep/aux/ | newview.ep |
| Zonal Means | data products | /uv/tprod/ep/zm/ | toz_35.ept |
| Zonal Means Processing Log | processing history | /uv/tprod/ep/memo/ | zm.log |
| Zonal Means Processing Parameters | system inputs | /tmp/ (not retained) | zmtoms98299$$ |
| Zonal Means Statistics | intermediate data | /uv/tprod/ep/zm/ | N_98.ept, minmax98.ept |

Details of each data product are in Appendix B. Included in Appendix B is information pertaining to content, processing schedule, data volume, format, location, and file naming convention. Software that reads and writes each data type is also listed in Appendix B.

**Intermediate Data**

Intermediate data files are those that are created during a production process primarily to pass data to another process. In its present form the EP/TOMS science processing software has the following intermediate data files:

- calibration history
- ephemeris QC parameters
- ephemeris reformatting parameters
- housekeeping history
- instrument status history
- local equator crossing history file
- master orbit data set (ODS)
- orbital counts
- orbital instrument level 0
- zonal means statistics

Details of each intermediate data file are in Appendix C. Included in Appendix C is information pertaining to content, processing schedule, data volume, format, location, and file naming convention. Software that reads and writes each data type is also listed in Appendix C.

**Processing History**

At each step in the EP/TOMS science data processing, information is stored regarding the results of the data processing. Included are summary statistics that are meant to be a permanent data inventory and messages required to assess the success of the processing. Details of each of the following processing history files are in Appendix D.

- backup logs
- ephemeris QC report
- level 1 processing statistics
- level 1 report file
- level 2 report file
- level 3 report file
- near real-time processing report
- orbit database
- playback history
- playback inventory
- spacecraft subset processing
- standard product processing
- zonal means processingg

Included in Appendix D is information pertaining to content, processing schedule, data volume, format, location, and file naming convention. Software that reads and writes each data type is also listed in Appendix D.

## 4.2 Data Storage

The location of data in the EP/TOMS science data processing system was introduced in Section 3.3. Additional details of each data storage directory follows.

***/uv/tprod/ep/aux/* (auxiliary files)**

The auxiliary files stored in */uv/tprod/ep/aux/* that are used for EP/TOMS data processing are listed in Table 4.2-1. This directory is shared with other TOMS missions. The following files are not used in EP/TOMS processing and are not described in this document:

- *ACF.A1, ACF.M3, & ACF.N7*

- *CONST.A1, CONST.M3, & CONST.N7*

## Table 4.2-1
## EP/TOMS Auxiliary Data Files
*(tparty:/uv/tprod/ep/aux/)*

| File Name | Content |
|---|---|
| ACF.EP | • albedo correction factors required by the ozone retrieval algorithm<br>• source: TOMS calibration analysis |
| CLDPRES.JAN<br>CLDPRES.FEB<br>CLDPRES.MAR<br>CLDPRES.APR<br>CLDPRES.MAY<br>CLDPRES.JUN<br>CLDPRES.JUL<br>CLDPRES.AUG<br>CLDPRES.SEP<br>CLDPRES.OCT<br>CLDPRES.NOV<br>CLDPRES.DEC | • monthly climatological cloud height used by the ozone retrieval algorithm<br>• source: ISSCP (7 year average)<br>• format: binary; 72 records, 1 for each $2.5^0$ latitude band from 90N to 90S. Each record contains 144 values of cloud top pressure (in mb) for each $2.5^0$ longitude starting at the Prime Meridian and proceeding eastward |
| CONST.EP | • constants (i.e. wavelengths, F, prelaunch calibration, inter-range ratios, Raman scattering coefficients, SO2 wavelength indices, absorption coefficients, N value adjustments, wavelength pair definitions, and error flag limits) required for ozone retrieval<br>• source: GSFC TOMS Science Team |
| ECLIPSE.DAT | • solar eclipse information used to determine exclusion zone in Level 2 processing<br>• source: Astronomical Almanac |
| ODS_D.EP<br>ODS_P.EP<br>ODS_P.EP_*yyyy*<br>ODS_P.EP_1996-*yyyy* | ~~• orbit crossing times used to assign orbit numbers~~<br>• Master ODS; orbit crossing times used to assign orbit numbers<br>• source: predictive and definitive spacecraft ephemeris data<br>• yearly ("yyyy") predictive orbit tables are maintained to facilitate possible future reprocessing<br>• as orbit tables accumulate in the Master ODS they are moved to ODS_P.EP_1996-*yyyy* to minimize sort/merge time during near real-time processing. |
| ORBCNTS_P.EP | orbital summary information from Level 2 processing |
| SNOICE.JAN<br>SNOICE.FEB<br>SNOICE.MAR<br>SNOICE.APR<br>SNOICE.MAY<br>SNOICE.JUN<br>SNOICE.JUL<br>SNOICE.AUG<br>SNOICE.SEP<br>SNOICE.OCT<br>SNOICE.NOV<br>SNOICE.DEC | • monthly climatological snow ice probability used in ozone retrieval<br>• source: Air Force Snow/Ice Climatology (30 year average)<br>• format: binary; 180 records of 363, 4 byte words. Each record represents a $1^0$ latitude band starting at 90S. The 1st 3 words of each record are integer with contents as follows:<br>word 1: disregard<br>word 2: month of year<br>word 3: record number<br>(i.e. 1=90S,...180=90N)<br>The remaining 360 values are real*4 probabilities for each degree of longitude starting at the Prime Meridian and proceeding eastward |

(continued on next page)

**Table 4.2-1** (continued from previous page)

**EP/TOMS Auxiliary Data Files**

*(tparty:/uv/tprod/ep/aux/)*

| File Name | Content |
|---|---|
| SURFCAT.DAT | • gridded ($1/2^o$ x $1/2^o$)surface category code<br>• source: surface category stored in the TUG87 geophysical model (Weiser, Technical Univ. of Graz, Austria)<br>• format: ASCII text; 2160 lines with 120 columns/line. Six rows are required for each latitude from 90N. Values within a latitude band start from the Prime Meridian and proceed eastward. 0 = ocean<br>1 = land<br>2 = low inland |
| SURFREFL.JAN<br>SURFREFL.FEB<br>SURFREFL.MAR<br>SURFREFL.APR<br>SURFREFL.MAY<br>SURFREFL.JUN<br>SURFREFL.JUL<br>SURFREFL.AUG<br>SURFREFL.SEP<br>SURFREFL.OCT<br>SURFREFL.NOV<br>SURFREFL.DEC | • monthly reflectivity tables used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| TABLE.EP | • total ozone lookup tables<br>• source: GSFC TOMS Science Team<br>• format: binary; 2 unformatted FORTRAN records.<br>The 1st record contains 5 real*4 arrays containing $\log_{10}I$, $Z_1/I_0$, $Z_2/I_0$, $T/I_0$, and $S_b$. Each , except $S_b$, is dimensioned (6,10,26,5,2) corresponding to (satellite zenith angles of 0, 15, 30, 45, 60, and 70 degrees, solar zenith angles of 0, 30, 45, 60, 70, 77, 81, 84, 86, and 88 degrees, ozone profile, ozone wavelength, and pressure at 1.0 and 0.4 atm). $S_b$ is dimensioned (26,5,2) as it is not a function of satellite or solar zenith angles. The 2nd record contains these values for the reflectivity wavelength. The arrays in this 2nd record are dimensioned as either (6,10,2) or (2). (see "The Version 7 TOMS Algorithm as Applied to Nimbus-7/TOMS" for data definitions) |
| TERPRS.DAT | • gridded ($1/2^o$ x $1/2^o$)terrain height<br>• source: elevations stored in the TUG87 geophysical model (Weiser, Technical Univ. of Graz, Austria)<br>• format: binary, real*4 array of terrain pressure, in mb, at 360 latitudes starting at 90N by 720 longitudes starting at the Prime Meridian and continuing eastward |

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**Table 4.2-1** (continued from previous page)

**EP/TOMS Auxiliary Data Files**

*(tparty:/uv/tprod/ep/aux/)*

| File Name | Content |
|---|---|
| climoz.sav | climatological total ozone for data validation use with */uv/tprod/ep/tool/ozhis* |
| climref.sav | climatological effective surface reflectivity for data validation use with */uv/tprod/ep/tool/ozhis* |
| disortrad360.dat | • used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| disortrad380.dat | • used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| eryth3.dat | • used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| lowrad360.dat | • used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| lowrad380.dat | • used in Level 3 Erythemal Exposure product generation<br>• source: Celarier, SCA (see Appendix O) |
| newep.fov | FOV area, longitudinal distance from the FOV center to the FOV edge, and the latitudinal distance from the FOV center to the FOV edge |
| newview.fov | satellite view angles at each scan position |
| toms_setup.ep | satellite specific environmental variables required by TOMS processing system as follows:<br>`# what`<br>`PROJNAME=TOMS-EP`<br>`PROJTAG=ept`<br>`LAUNCHD=1996184`<br>`INIDATADAY=1996198`<br>`SATID=9603701`<br><br>`# where`<br>`PATH=/usr/bsd:/bin:/usr/bin:/usr/sbin:/usr/bin/X11:`<br>`/usr/local/bin:/usr/local/sbin:/usr/local/rbin:/usr/lib:`<br>`/uv/tprod/ep/bin`<br>`TOMSROOT=/uv/tprod/ep`<br>`TMPDIR=/uv/tprod/ep/tmp`<br>`DB_DIR=/uv/tprod/ep/db`<br>`TOMSAUX=/uv/tprod/ep/aux`<br>`ANONYPUB=/app/ftptoms/pub/eptoms`<br>`ZERODIR=/home/tmoc`<br>`EPHDIR=/home/fdf`<br><br>`# who (address lists for processing report e-mail)`<br>`TASKLEAD=byerly`<br>`CALIBER=byerly,jaross,mattk@hoss.stx.com`<br>`TOMSPROD=tomsprod`<br>`MONITOR=tomsprod`<br>`BACKUP=byerly` |
| v2hdf_toms.ep | file description metadata for Level 2 Standard Product |
| v3hdf_toms.ep | file description metadata for Level 3 Standard Product |

- *DELVIEW.N7*
- *ODS_D.A1* & *ODS_P.A1*
- *ORBCNTS.A1, ORBCNTS.M3, ORBCNTS.N7,* & *ORBCNTS_P.A1*
- *RUTSTAT.ABS*
- *TABLE.A1, TABLE.M3,* & *TABLE.N7*
- *TIMECODE_P.A1 & TIMECODE_T_A1*
- *anchor_his.m3*
- *correct_par.m3*
- *lect_par.m3*
- *orbsdb.m3* & *orbsdb.n7*
- *playbk_idx.m3*
- *toms_setup.a1, toms_setup.m3,* & *toms_setup.n7*
- *v2hdf_toms.m3, v2hdf_toms.n7,* & *v2hdf_toms_ver.n7*
- *v3hdf_oz, v3hdf_ref, v3hdf_toms, v3hdf_toms_ver.m3,* & *v3hdf_toms_ver.n7*

Detailed descriptions of the files in the */uv/tprod/ep/aux/* directory that are used in EP/TOMS science data processing are in Appendices A, C, and D.

***/uv/tprod/ep/cal/* (calibration data files)**

The */uv/tprod/ep/cal/* directory is used to store files related to instrument calibration analysis. Calibration products stored in this directory are described in Appendix B.

***/uv/tprod/ep/db/* (operations and product inventory databases)**

*/uv/tprod/ep/db/EP_ORB_DB* is the orbit database for EP/TOMS. This database stores EP/TOMS equator crossing times and locations. */uv/tprod/ep/db/EP_PROD_DB* and */uv/tprod/ep/db/EP_PROD_DB3* contain inventories of Level 2 and Level 3 Standard Product files respectively. These databases are described in Appendix D.

***/uv/tprod/ep/memo/* (information and processing history)**

The files that are stored in the */uv/tprod/ep/memo/* directory and used for EP/TOMS science data processing are listed in Table 4.2-2. This directory contains the following subdirectories.

Subdirectory */uv/tprod/ep/memo/ar_tape/* contains the following files:

- *EPH_D* - record of definitive EPHEM backups
- *EPH_P* - record of predictive EPHEM backups
- *hdf* - record of Level 2 and Level 3 Standard Product backups
- *io* - record of orbital Instrument Level 0 File backups
- *ip* - record of playback Instrument Level 0 File backups
- sc - record of Spacecraft Level 0 File backups backups
- *v1* - record of definitive ephemeris and Level 1 backups
- *v1rpt* - record of Level 1 processing report backups

These files are updated whenever it becomes necessary to free disk space by moving data files to tape.

Subdirectory */uv/tprod/ep/memo/mail/* contains detailed reports for each automated near real-time science data processing. Included in these reports are the outputs from the various file QC programs that were executed. Files in this subdirectory are named according to the Level 0 data files that were processed.

# Table 4.2-2
# EP/TOMS Information and Processing History Files
*(tparty:/uv/tprod/ep/memo/)*

| File Name | Content |
|---|---|
| backup_eph.log | • log of ephemeris data back up<br>• written by */uv/tprod/ep/bin/backup_eph &* */uv/tprod/ep/bin/backup_eph_bat*<br>• excerpt follows:<br>`>>> backup_eph: 181/1997-181/1997 /misc/mhdat22/ep/arch/eph <<<`<br>`mput: #1 entry= 2:`<br>`D970630_D970704.EPH`<br>`D970630_D970704.ODS`<br>`#Total_days=1 #Files_put=2 #Bad=0`<br>`<<< backup_eph: /uv/tprod/ep/v1 10/02/97 11:46 >>>` |
| backup_vzi.log | • log of instrument level 0 data back up<br>• written by */uv/tprod/ep/bin/backup_vz* and */uv/tprod/ep/bin/backup_vz_bat*<br>• excerpt follows:<br>`>>>backup_vz: 273/1997 - 274/1997 <<<`<br>`mput: #1 entry= 2:`<br><br>`i9727304_9727315.w`<br>`i9727315_9727415.w`<br>`mput: #2 entry= 1:`<br>`i9727415_9727504.w`<br>`#Total_days=2 #Bad=0 #Files_put=3`<br>`<<<backup_vz: /uv/tprod/ep/v0i 10/02/97 03:17 >>>` |
| backup_vzss.log | • log of spacecraft level 0 subset back up<br>• written by */uv/tprod/ep/bin/backup_vz* and */uv/tprod/ep/bin/backup_vz_bat*<br>• excerpt follows:<br>`>>>backup_vz: 273/1997-274/1997 /misc/mhdat22/ep/arch/v2d/y97 <<<`<br>`mput: #1 entry= 4:`<br>`ss9727304_9727315.w`<br>`ss9727315_9727415.w`<br>`ss9727315_9727415.w1`<br>`ss9727315_9727415.w2`<br>`mput: #2 entry= 1:`<br>`ss9727415_9727504.w`<br>`#Total_days=2 #Bad=0 #Files_put=5`<br>`<<<backup_vz: /uv/tprod/ep/v0s/sub 10/02/97 03:31 >>>` |
| earthprobe_data_coverage | ▪ log of daytime Earth view data coverage<br>▪ identifies partial and missing orbits<br>▪ lists orbits with data recorded in 'stare mode'<br>▪ located in /uv/tprod/ep/memoe |
| playback | • log of near real-time Level 0 ingest for current year<br>• written by */uv/tprod/ep/bin/playhis.exe*<br>• excerpt follows:<br>`EP/TOMS Playback History Log :`<br>`Size Bytes Creatn Time TMOC File SOC Level-0a File S.Orb E.Orb Time Stamp`<br>`---------- ------------ ------------ ------------------ ----- ----- ------------`<br>`14249848 Jan 01 02:06 w08312sa.3vz => s9736520_9800103.w Jan 1 02:15`<br>`2167296 Jan 01 02:05 w08312ia.3vz => i9736520_9800103.w ( 8308- 8312) Jan 1 02:15`<br>`25917140 Jan 01 12:34 w08320sa.3vz => s9800103_9800116.w Jan 1 12:45`<br>`3944824 Jan 01 12:33 w08320ia.3vz => i9800103_9800116.w ( 8312- 8320) Jan 1 12:45`<br>`24598388 Jan 02 00:33 w08327sa.3vz => s9800116_9800204.w Jan 2 00:45`<br>`3742968 Jan 02 00:31 w08327ia.3vz => i9800116_9800204.w ( 8320- 8327) Jan 2 00:45`<br>`22528680 Jan 02 14:56 w08334sa.3vz => s9800204_9800215.w Jan 2 15:00`<br>`3429560 Jan 02 14:55 w08334ia.3vz => i9800204_9800215.w ( 8327- 8334) Jan 2 15:00`<br>`27876952 Jan 03 01:26 w08342sa.3vz => s9800215_9800305.w Jan 3 01:30`<br>`4242296 Jan 03 01:24 w08342ia.3vz => i9800215_9800305.w ( 8334- 8342) Jan 3 01:30`<br>`22528680 Jan 03 12:50 w08349sa.3vz => s9800305_9800316.w Jan 3 13:00`<br>`3429560 Jan 03 12:49 w08349ia.3vz => i9800305_9800316.w ( 8342- 8349) Jan 3 13:00`<br>`24598388 Jan 04 00:42 w08356sa.3vz => s9800316_9800404.w Jan 4 00:45` |

(continued on next page)

## Table 4.2-2 (continued from previous page)
## EP/TOMS Information and Processing History Files
*(tparty:/uv/tprod/ep/memo/)*

<table>
<tr><th>File Name</th><th>Content</th></tr>
<tr><td>prohis</td><td>
• log of near real-time processing for current year<br>
• written by /uv/tprod/ep/bin/rufqc.exe<br>
• excerpt follows:<br><br>
<pre>
14249848 Jan 01 02:06 w08312sa.3vz => S9736520_9800103.W              Jan  1 02:15
   2167296 Jan 01 02:05 w08312ia.3vz => i9736520_9800103.w ( 8308- 8312) Jan  1 02:15
Orbno S_YYMMDD S_Time E_YYMMDD E_Time Skn Scc Scw Scr Wmn Ecl Rcc Rcw Rcr St_By
----- -------- ------ -------- ------ --- --- --- --- --- --- --- --- --- -----
08308 19971231  73111 19971231  79087 383  30   0   0   0   0   0   0   0   352
08309 19971231  79095 19971231  85070 383  30   0   0   0   0   0   0   0   352
08310 19971231  85078 19980101   4654 383   0   0   0   0   0   0   0   0   382
08311 19980101   4661 19980101  10637 383  30   0   0   0   0   0   0   0   352
08312 19980101  10645 19980101  12891 138  30   0   0   0   0   0   0   0   120
  25917140 Jan 01 12:34 w08320sa.3vz => s9800103_9800116.w              Jan  1 12:45
   3944824 Jan 01 12:33 w08320ia.3vz => i9800103_9800116.w ( 8312- 8320) Jan  1 12:45
Orbno S_YYMMDD S_Time E_YYMMDD E_Time Skn Scc Scw Scr Wmn Ecl Rcc Rcw Rcr St_By
----- -------- ------ -------- ------ --- --- --- --- --- --- --- --- --- -----
08312 19980101  10645 19980101  16620 383  30   0   0   0   0   0   0   0   352
08313 19980101  16628 19980101  22604 383  30   0   0   0   0   0   0   0   352
08314 19980101  22611 19980101  28587 383  30   0   0   0   0   0   0   0   352
08315 19980101  28595 19980101  34570 383  30   0   0   0   0   0   0   0   352
</pre>
</td></tr>
<tr><td>readme.ep.gap</td><td>detailed information concerning data gaps</td></tr>
<tr><td>readme.v0ss</td><td>information concerning spacecraft level 0 subsets</td></tr>
<tr><td>v0ssub.log</td><td>
• log of spacecraft subset processing<br>
• written by /uv/tprod/ep/bin/reals_ep<br>
• excerpt follows:<br><br>
<pre>
Subsetting Level-0 Spacecraft data for 002/97 at Thu Jan  2 13:08:44 EST 1997 ...
input =/uv/tprod/ep/v0s/s9700203_9700215.w
output=/uv/tprod/ep/v0s/sub/ss9700203_9700215.w
total_majorframe=1348 bad=1
Total number of records stripped from Spacecraft Level-0: 1348
v0ssubqc: /uv/tprod/ep/v0s/sub/ss9700203_9700215.w passed QC
================================================================
</pre>
</td></tr>
<tr><td>zm.log</td><td>
• log of near real-time zonal means processing<br>
• written by /uv/tprod/ep/bin/zmtoms_bat<br>
• excerpt follows:<br><br>
<pre>
***** zmtoms_bat: starting at  04/24/97 01:46:54 *****
Ran /uv/tprod/ep/bin/zmtoms ept-1996198 1997113-1997113 /uv/tprod/ep/nrt/v2d/s
/uv/tprod/ep/zm/ /uv/tprod/ep/tmp 1-35-16 .true. 2=0,10 .true.

Updating zonal means for 113/1997 - 113/1997 ...

Accessing #1 /uv/tprod/ep/nrt/v2d/s97113.ept ...

 /uv/tprod/ep/nrt/v2d/s97113.ept
  latitude bounds   -85.00000       85.00000
  number of zones          17
  number of different data sets with scan positions          37
  no. of flags   2 with values   0 10
  high and low scans            1          35
  start of 5 weighted averaged scans          16
  Date  1997113.  DA data set record # 282  Initial data collection day 1996198
  getect= F nasc=          15 ndes=           0
 Total number of data sets updated:   114
 zmtoms updated for day 1997113
Total 1 days(s): 1 updated.
</pre>
</td></tr>
</table>

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Subdirectory */uv/tprod/ep/memo/playback_old/* contains near real-time Level 0 ingest logs from previous years (see content description of *playback* file in Table 4.2-2).

Subdirectory */uv/tprod/ep/memo/prohis_old/* contains near real-time processing logs from previous months (see content description of *prohis* file in Table 4.2-2).

Subdirectory */uv/tprod/ep/memo/weekly/* contains text information that is used to generate the weekly processing report. The week is identified by the file name.

***/uv/tprod/ep/nrt/* (near real-time science data and products)**

The subdirectories in*/uv/tprod/ep/nrt/* store Level 0 science data files and science data products that are received and produced in near real-time. Near real-time files are mapped to these subdirectories as follows:

- */uv/tprod/ep/nrt/v0ib/* - instrument level 0 files (orbital)
- */uv/tprod/ep/nrt/v1/* - predictive S/C ephemeris & near real-time level 1 product files
- */uv/tprod/ep/nrt/v1/rpt/* - near real-time level 1 report files
- */uv/tprod/ep/nrt/v1/y*YYYY*/* - near real-time daily level 1 files for year YYYY
- */uv/tprod/ep/nrt/v2/* - near real-time level 2 product files
- */uv/tprod/ep/nrt/v2/rpt/* - near real-time level 2 report files
- */uv/tprod/ep/nrt/v2/y*YYYY*/* - near real-time level 2 files for year YYYY
- */uv/tprod/ep/nrt/v2d/* - near real-time daily level 2 product files
- */uv/tprod/ep/nrt/v2d/rpt/* - near real-time daily level 2 report files
- */uv/tprod/ep/nrt/v2d/y*YYYY*/* - near real-time daily level 2 files for year YYYY
- */uv/tprod/ep/nrt/v3/rpt/* - near real-time level 3 report files
- */uv/tprod/ep/nrt/v3/y*YYYY*/* - near real-time level 3 product files for year YYYY
- */uv/tprod/ep/nrt/v3/y*YYYY*/oz/* -total ozone for year YYYY
- */uv/tprod/ep/nrt/v3/y*YYYY*/ery/* -erythemal UV for year YYYY
- */uv/tprod/ep/nrt/v3/y*YYYY*/ref/* -effective surface reflectivity for year YYYY
- */uv/tprod/ep/nrt/v3/y*YYYY*/res/* -aerosol (331 nm residue) for year YYYY
- */uv/tprod/ep/nrt/v3map/* - near real-time level 3 ozone images (not currently used)

Details concerning the near real-time science input and product files are in Appendices A and B.

***/uv/tprod/ep/ovp/* (overpass files)**

This directory was used to store overpass files from a now retired Overpass Processing Subsystem. In the future it will store overpass files from a new Overpass Processing Subsystem that is under development.

***/uv/tprod/ep/tle/* (2 line elements)**

The use of 2 line elements as source data for generating predictive spacecraft ephemeris has not been necessary for EP/TOMS. This directory will store these elements if needed in the future.

***/uv/tprod/ep/tmp/* (temporary files)**

This directory provides a short-term storage location for miscellaneous temporary files. Unlike the system's */tmp/* directory files remain in */uv/tprod/ep/tmp/* until explicitly deleted.

***/uv/tprod/ep/v0/* (playback Level 0 Files)**
Instrument and Spacecraft Level 0 Files are stored in this directory before they pass quality control checks. Files that pass QC are moved to */uv/tprod/ep/v0i/* (Instrument Level 0) or */uv/tprod/ep/v0s/* (Spacecraft Level 0). Rejected files are moved to */home/tmoc/reject/*. Detailed descriptions of Level 0 files are in Appendix A.

***/uv/tprod/ep/v0ib/* (orbital Instrument Level 0 Files)**
This directory stores orbital Instrument Level 0 Files. Data coverage of each file begins with the first scan following an ascending node equator crossing and ends just before the next ascending node equator crossing. These files are identical in format to EP/TOMS playback Instrument Level 0 Files delivered by TMOC.

***/uv/tprod/ep/v1/* (definitive S/C ephemeris and future reprocessed Level 1 files)**
Definitive ephemeris and orbit table files produced from definitive FDF Spacecraft Ephemeris (EPHEM) files and future reprocessed Level 1 files are/will be stored in */uv/tprod/ep/v1/*. Level 1 processing report files from future reprocessing will be stored in */uv/tprod/ep/v1/rpt/*. Detailed descriptions of Level 1 data and report files are in Appendix B and Appendix D respectively.

***/uv/tprod/ep/v1sub/* (Level 1 Subset files)**
Yearly subdirectories (i.e. */uv/tprod/ep/v1sub/yYYYY/*) contain the following Level 1 subset files:

- *rufabs_his.ep* - processing statistics
- *rufcal_his.ep* - calibration history
- *rufhk_his.ep* - housekeeping history
- *rufinst_his.ep* - instrument status history
- *ruflect_his.ep* - local equator crossing time history

Subset files are updated every couple of months. Detailed descriptions of these subset files are in Appendix C.

***/uv/tprod/ep/v2/* (future reprocessed Level 2 (native) files)**
Native format Level 2 files produced during future reprocessings will be stored in */uv/tprod/ep/v2/*. Level 2 reprocessing report files will be stored in */uv/tprod/ep/v2/rpt/*. See Appendix B and the "EP/TOMS Data Products User's Guide" for detailed descriptions of EP/TOMS Level 2 files.

***/uv/tprod/ep/v2d/* (future reprocessed daily Level 2 (native) files)**
Daily native format Level 2 files produced during future reprocessings will be stored in */uv/tprod/ep/v2d/*. Daily Level 2 reprocessing report files will be stored in */uv/tprod/ep/v2d/rpt/*. See Appendix B for detailed descriptions of EP/TOMS Daily Level 2 files.

***/uv/tprod/ep/v2hdf/* (Level 2 Standard (HDF) Product Files)**
Level 2 (HDF) Standard Product Files are stored in yearly subdirectories under */uv/tprod/ep/v2hdf/*. See Appendix B and the "EP/TOMS Data Products User's Guide" for detailed descriptions of EP/TOMS Level 2 Standard Product files.

***/uv/tprod/ep/v3/* (future reprocessed Level 3 files)**

Level 3 ASCII files from future reprocessings will be stored in subdirectories under */uv/tprod/ep/v3/*. The subdirectories and their contents are:

- */uv/tprod/ep/v3/rpt/* - level 3 report files
- */uv/tprod/ep/v3/*yYYYY/ - level 3 ASCII files for year YYYY
- */uv/tprod/ep/v3/yYYYY/oz/* - total ozone for year YYYY
- */uv/tprod/ep/v3/yYYYY/ref/* - effective surface reflectivity for year YYYY
- */uv/tprod/ep/v3/yYYYY/ery/* - Erythemal UV for year YYYY
- */uv/tprod/ep/v3/yYYYY/res/* - aerosol (331 nm residue) for year YYYY

See Appendix B and the "EP/TOMS Data Products User's Guide" for detailed descriptions of EP/TOMS Level 3 ASCII files.

***/uv/tprod/ep/v3hdf/* (Level 3 Standard (HDF) Product Files)**

Level 3 (HDF) Standard Product Files are stored in */uv/tprod/ep/v3hdf/*. See Appendix B and the "EP/TOMS Data Products User's Guide" for detailed descriptions of EP/TOMS Level 3 Standard Product files.

***/uv/tprod/ep/zm/* (Zonal Means Files)**

The */uv/tprod/ep/zm/* directory contains 114 Level 2 Zonal Means files as listed in Table 4.2-3. Level 3 Zonal Means files and Zonal Means Statistics files are also stored in this directory. The format of these files is described in Appendix B.

## Table 4.2-3
## EP/TOMS Level 22 Zonal Means Files
*(/uv/tprod/ep/zm/)*

| File Name | Content |
|---|---|
| adr308_01.ept<br>adr308_35.ept<br>adr308_nad.ept | zonal mean statistics of adjusted 308 nm residues at scan positions 1, 18 (nadir), and 35 |
| adr312_01.ept<br>adr312_35.ept<br>adr312_nad.ept | zonal mean statistics of adjusted 312 nm residues at scan positions 1, 18 (nadir), and 35 |
| adr317_01.ept<br>adr317_35.ept<br>adr317_nad.ept | zonal mean statistics of adjusted 317 nm residues at scan positions 1, 18 (nadir), and 35 |
| adr322_01.ept<br>adr322_35.ept<br>adr322_nad.ept | zonal mean statistics of adjusted 322 nm residues at scan positions 1, 18 (nadir), and 35 |
| atr_01.ept<br>atr_35.ept<br>atr_nad.ept | zonal mean statistics of A-triplet total ozone at scan positions 1, 18 (nadir), and 35 |
| btr_01.ept<br>btr_35.ept<br>btr_nad.ept | zonal mean statistics of B-triplet total ozone at scan positions 1, 18 (nadir), and 35 |
| cldfrc_01.ept<br>cldfrc_35.ept<br>cldfrc_nad.ept | zonal mean statistics of Effective Cloud Fraction at scan positions 1, 18 (nadir), and 35 |
| cldprs_01.ept<br>cldprs_35.ept<br>cldprs_nad.ept | zonal mean statistics of Cloud Pressure at scan positions 1, 18 (nadir), and 35 |
| ctr_01.ept<br>ctr_35.ept<br>ctr_nad.ept | zonal mean statistics of C-triplet total ozone at scan positions 1, 18 (nadir), and 35 |
| dndr308_01.ept<br>dndr308_35.ept<br>dndr308_nad.ept | zonal mean statistics of 308 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |
| dndr312_01.ept<br>dndr312_35.ept<br>dndr312_nad.ept | zonal mean statistics of 3122 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |
| dndr317_01.ept<br>dndr317_35.ept<br>dndr317_nad.ept | zonal mean statistics of 317 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |
| dndr322_01.ept<br>dndr322_35.ept<br>dndr322_nad.ept | zonal mean statistics of 322 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |

(continued on next page)

**Table 4.2-3** (continued from previous page)

**EP/TOMS Level 22 Zonal Means Files**

*(/uv/tprod/ep/zm/)*

| File Name | Content |
|---|---|
| dndr331_01.ept<br>dndr331_35.ept<br>dndr331_nad.ept | zonal mean statistics of 331 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |
| dndr360_01.ept<br>dndr360_35.ept<br>dndr360_nad.ept | zonal mean statistics of 360 nm reflectivity sensitivity (dN/dR) at scan positions 1, 18 (nadir), and 35 |
| dtr_01.ept<br>dtr_35.ept<br>dtr_nad.ept | zonal mean statistics of B-triplet (with profile selection) total ozone at scan positions 1, 18 (nadir), and 35 |
| hisamp.ept | maximum total ozone |
| losamp.ept | minimum total ozone |
| mxfr_01.ept<br>mxfr_35.ept<br>mxfr_nad.ept | zonal mean statistics of mixing fraction at scan positions 1, 18 (nadir), and 35 |
| n3086_01.ept<br>n3086_35.ept<br>n3086_nad.ept | zonal mean statistics of 308 nm N values at scan positions 1, 18 (nadir), and 35 |
| n3125_01.ept<br>n3125_35.ept<br>n3125_nad.ept | zonal mean statistics of 312 nm N values at scan positions 1, 18 (nadir), and 35 |
| n3175_01.ept<br>n3175_35.ept<br>n3175_nad.ept | zonal mean statistics of 317 nm N values at scan positions 1, 18 (nadir), and 35 |
| n3223_01.ept<br>n3223_35.ept<br>n3223_nad.ept | zonal mean statistics of 322 nm N values at scan positions 1, 18 (nadir), and 35 |
| n3312_01.ept<br>n3312_35.ept<br>n3312_nad.ept | zonal mean statistics of 331 nm N values at scan positions 1, 18 (nadir), and 35 |
| n3600_01.ept<br>n3600_35.ept<br>n3600_nad.ept | zonal mean statistics of 360 nm N values at scan positions 1, 18 (nadir), and 35 |
| ozcld_01.ept<br>ozcld_35.ept<br>ozcld_nad.ept | zonal mean statistics of ozone below cloud at scan positions 1, 18 (nadir), and 35 |
| ozdiff.ept | total ozone range |

(continued on next page)

**Table 4.2-3** (continued from previous page)

**EP/TOMS Level 22 Zonal Means Files**

*(/uv/tprod/ep/zm/)*

| File Name | Content |
|---|---|
| phi_01.ept<br>phi_35.ept<br>phi_nad.ept | zonal mean statistics of $\phi$ angle at scan positions<br>1, 18 (nadir), and 35 |
| pres_01.ept<br>pres_35.ept<br>pres_nad.ept | zonal mean statistics of terrain pressure at scan positions<br>1, 18 (nadir), and 35 |
| prthir_01.ept<br>prthir_35.ept<br>prthir_nad.ept | zonal mean statistics of cloud pressure at scan positions<br>1, 18 (nadir), and 35 |
| ref_01.ept<br>ref_35.ept<br>ref_nad.ept | zonal mean statistics of effective surface reflectivity at scan positions<br>1, 18 (nadir), and 35 |
| res331_01.ept<br>res331_35.ept<br>res331_nad.ept | zonal mean statistics of 331 nm residue at scan positions<br>1, 18 (nadir), and 35 |
| sen308_01.ept<br>sen308_35.ept<br>sen308_nad.ept | zonal mean statistics of 308 nm sensitivity at scan positions<br>1, 18 (nadir), and 35 |
| sen312_01.ept<br>sen312_35.ept<br>sen312_nad.ept | zonal mean statistics of 312 nm sensitivity at scan positions<br>1, 18 (nadir), and 35 |
| sen317_01.ept<br>sen317_35.ept<br>sen317_nad.ept | zonal mean statistics of 317 nm sensitivity at scan positions<br>1, 18 (nadir), and 35 |
| sen322_01.ept<br>sen322_35.ept<br>sen322_nad.ept | zonal mean statistics of 322 nm sensitivity at scan positions<br>1, 18 (nadir), and 35 |
| sen331_01.ept<br>sen331_35.ept<br>sen331_nad.ept | zonal mean statistics of 331 nm sensitivity at scan positions<br>1, 18 (nadir), and 35 |
| soi_01.ept<br>soi_35.ept<br>soi_nad.ept | zonal mean statistics of $SO_2$ index at scan positions<br>1, 18 (nadir), and 35 |
| sza_01.ept<br>sza_35.ept<br>sza_nad.ept | zonal mean statistics of solar zenith angle at scan positions<br>1, 18 (nadir), and 35 |
| toz_01.ept<br>toz_35.ept<br>toz_nad.ept | zonal mean statistics of total ozone at scan positions<br>1, 18 (nadir), and 35 |

# 5. Software Description

## 5.1 Science Data Processing Subsystems

The subsystems that make up the EP/TOMS Science Data Processing System (see Figure 5.1-1) are presented in this section. Data flow diagrams are included for each subsystem. In these diagrams organizations that provide data to, or receive products from, the EP/TOMS Science Operations Center are indicated in rectangles. Data stores are shown using parallel horizontal lines bordering text that gives data type names and sample file names. Each processing program is shown as a circle and each circle is labeled with the subsystem name and abbreviation. Optional data flows (and programs) are shown with dashed lines. Optional data flows are those that do not occur during the normal production process. These diagrams show only the flow of data through each subsystem; the scripts that control the processing through and between these subsystems are described in Section 5.3.

### 5.1.1 Ephemeris Processing Subsystem

Figure 5.1.1-1 shows the EP/TOMS Ephemeris Processing Subsystem. The source of S/C ephemeris data is the GSFC FDF. Output from this subsystem is used during Level 0 file ingest and Level 1 file generation. Predicted ephemeris and orbit table output files are used in near real-time processing and are automatically distributed to NOAA NESDIS from this subsystem.

There are 5 C programs (*ephingest.c, eph_bridge.c, ephqccom.c, odsmerg.c,* and *eph_dump.c*) and 2 FORTRAN programs (*reblk_fmt_i2u.f* and *ephqc.f*) in this subsystem. The Ephemeris Processing Subsystem software is invoked and controlled by the *ephingest*, *ephqc*, *odsmerg*, and *eph_dump* process control scripts (see Section 5.3). The *noaa_volcano* shell script distributes predictive S/C ephemeris and orbit table files to NOAA NESDIS.

The *ephingest* process control script is executed automatically by the UNIX cron utility (see Section 5.3). It calls the following program's executables in sequence until either the process completes or a fatal error occurs: *ephingest.c*, *reblk_fmt_i2u.c*, *ephqccom.c*, and *odsmerg.c*. If processing a predictive ephemeris file then the *noaa_volcano* script is executed. The *ephqc.f* program's executable is called from the *ephqccom.c* program.

The *ephqc* and *odsmerg* process control scripts can be executed for standalone execution of the *ephqc.f* and *odsmerg.c* programs. The Operator Menu Interface (see Section 5.5.3.2) includes calls to these scripts. The *eph_dump* helper script can be used to call the *eph_dump.c* program's executable from either the command line or through the Operator Menu Interface. It interactively prompts for the input parameters required by *eph_dump.c.* The *eph_dump.c* program is typically used only to support software maintenance and problem analysis activities.

Details of each of the ephemeris processing programs are in Appendix E. A description of the input FDF EPHEM (IBM format) File is in Appendix A. Output Spacecraft Ephemeris (UNIX format) and Orbit Table files are described in Appendix B. Descriptions of intermediate data files (i.e. the Ephemeris QC Parameter File and the Master Orbit Table File)

are in Appendix C. Details about the Ephemeris QC Report File are in Appendix D.

## Figure 5.1-1
## EP/TOMS Science Data Processing Subsystems

Ephemeris Processing Subsystem (*eph*)
- Ephemeris Ingest program (*ephingest.c*)
- Reformat IBM to UNIX program (*reblk_fmt_i2u.f*)
- Ephemeris Bridge program (*eph_bridge.c*)
- Ephemeris QC program (*ephqc.f*)
- Ephemeris QC Driver program (*ephqccom.c*)
- ODS Merge program (*odsmerg.c*)
- Ephemeris Dump program (*eph_dump.c*)

Level 0 Ingest Subsystem (*v0*)
- Level 0 Ingest program (*v0ingest.c*)
- Level 0 Inventory program (*v0invent.c*)
- Get Previous Level 0 Filename program (*v0p4c.c*)
- Instrument Level 0 QC program (*v0iqc.c*)
- Instrument Level 0 Merge program (*v0imkorb.c*)
- Update Playback History Database program (*playhis.c*)
- Instrument Level 0 Dump program (*v0idump.c)*
- Spacecraft L0 QC program (*v0sqc.c*)
- Subset Spacecraft Level 0 program (*v0sstrip.c*)
- Spacecraft Subset QC program (*v0ssubqc.c*)
- Spacecraft Level 0 Dump program (*v0sdump.c*)
- Spacecraft Subset Dump program (*v0ssubdump.c*)

Auxiliary Subsystem (*aux*)
- Solar Eclipse Update program (*eclipse.c*)
- FOV Constants Generation program (*fov_const.pro*)
- View Angle Generation program (*view_angle.pro*)

Level 1 Processing Subsystem (*v1)*
- Level 1 File Generation program (*rufgen.c*)
- Level 1 File Generation Driver program (*rufgencom.c*)
- Level 1 File QC program (*rufqc.c*)
- Level 1 File QC Driver program (*rufqccom.c*)
- Level 1 Subset File Update program (*rufsub_up.c*)
- Level 1 (RUF) Dump program (*ruf_dump.c*)
- Level 1 Processing Statistics Dump program (*rufabs_dump.c*)
- Calibration History Dump program (*rufcal_dump.c*)
- Housekeeping History Dump program (*rufhk_dump.c*)
- Instrument Status History Dump program (*rufinst_dump.c*)

Calibration Subsystem (*cal*)
- Intervention Products Generation program (*ivpdr.f*)
- Intervention Products Generation Driver program (*ivprod.c*)
- Albedo Correction File Generation program (*acfgen.f*)
- Albedo Correction File Initialization program (*acffill.f*)
- Albedo Correction File Dump program (*acfdump.f*)
- Diffuser Time Series Generation program (*degrade.pro*)
- ACF Time Series Update program (*acfplt.pro*)

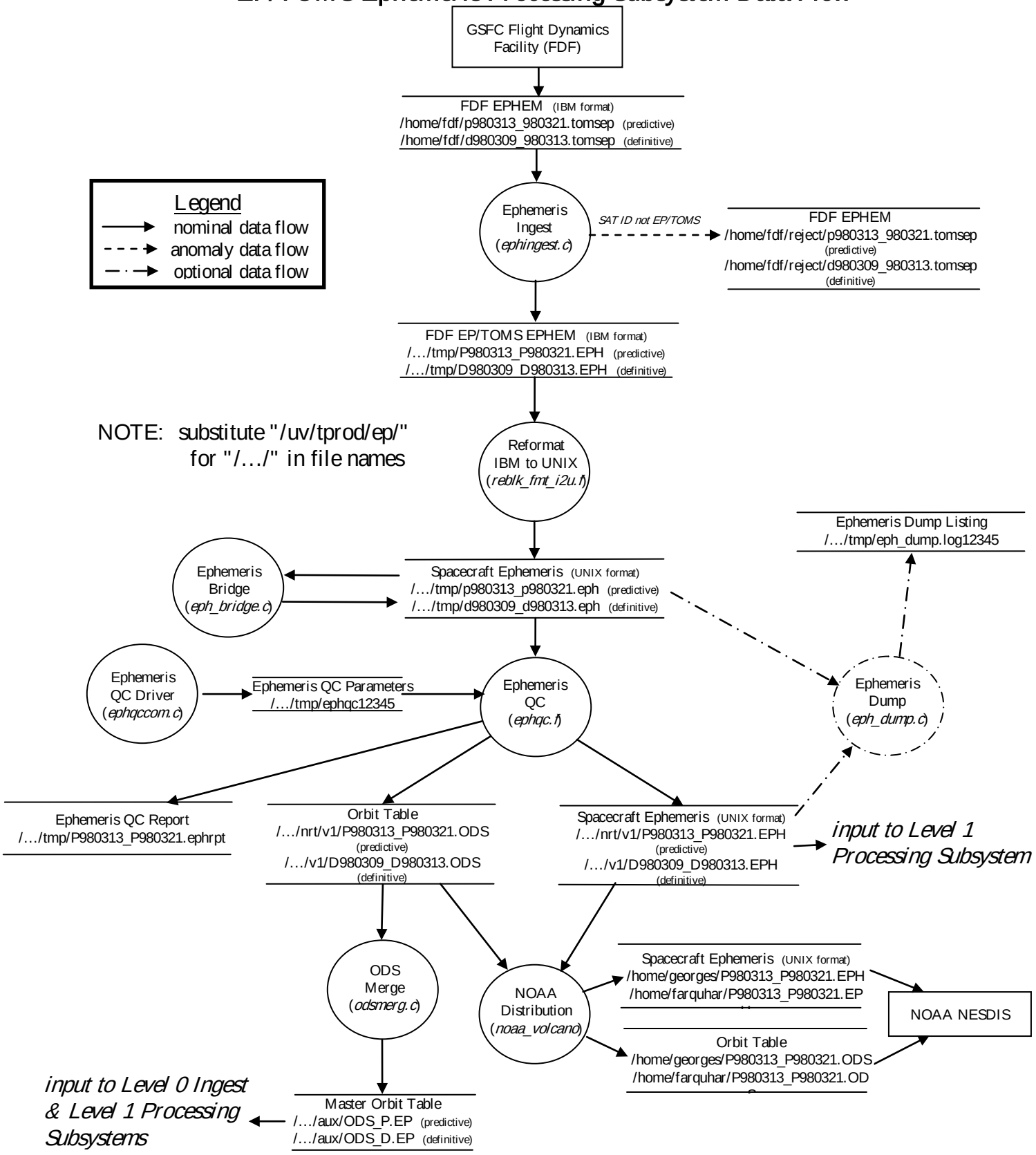
Level 2 Processing Subsystem (*v2*)
- Level 2 File Generation program (*ozt.f*)
- Level 2 File Generation Driver program (*oztcom.c*)
- Level 2 File QC program (*oztqc.c*)
- Level 2 File QC Driver program (*oztqccom.c*)
- Level 2 Dump program (*oztdump.c*)
- Level 2 Daily File Generation (*ozto2d.c*)
- Level 2 HDF File Generation program (*v2hdfgen.c*)
- Level 2 HDF File QC program (*v2hdfqc.c*)
- Level 2 HDF File Dump program (*v2hdfread.c*)

Overpass Processing Subsystem (*ovp)*

Zonal Means Processing Subsystem (*zm*)
- Daily Level 3 Zonal Means File Generation program (*l3zmdly.f*)
- Monthly Level 3 Zonal Means File Generation program (*l3zmmly.f*)
- Zonal Means File Generation program (*zmtoms.f*)}
- Zonal Means Dump program (*zmtoms_dump.f*)}

Level 3 Processing Subsystem (*v3*)
- Level 3 ASCII File Generation program (*gridt.f*)
- Level 3 ASCII File Generation Driver program (*gridtcom.c*)
- Level 3 File QC program (*cdtomsqc.c*)
- Level 3 HDF File Generation program (*v3hdfgen.c*)
- Level 3 HDF File Generation Driver program (*v3hdfgencom.c*)
- Level 3 HDF File QC program (*v3hdfqc.c*)
- Level 3 HDF Dump program (*v3hdfread.c*)
- Level 3 Monthly Averages File Generation program (*monav.f*)

# Figure 5.1.1-1
# EP/TOMS Ephemeris Processing Subsystem Data Flow



### 5.1.2 Level 0 Ingest Subsystem

Figure 5.1.2-1 shows the EP/TOMS Level 0 Ingest Subsystem. ~~The source of Level 0 data is the GSFC TMOC.~~ Output from this subsystem is used in Level 1 file generation. Also n~~N~~ear real-time Instrument Level 0 files are distributed to NOAA NESDIS from this subsystem. The source of Level 0 input data is the GSFC TMOC.

There are 12 C programs (*v0ingest.c, v0invent.c, v0idump.c, v0iqc.c, v0p4c.c, v0sqc.c, v0sdump.c, v0imkorb.c, playhis.c, v0sstrip.c, v0ssubqc.c,* and *v0ssubdump.c*) in this subsystem. ~~The *noaa_volcano* script is shared with the Ephemeris Processing Subsystem.~~ The Level 0 Ingest Subsystem software is invoked and controlled by the *v0ingest*, *reali_ep*, *reals_ep*, *v0iqc*, *v0imkorb*, *v0sqc*, and *v0sstrip* process control scripts (see Section 5.3). The *noaa_volcano* shell script distributes Instrument Level 0 files to NOAA NESDIS. The *noaa_volcano* script is shared with the Ephemeris Processing Subsystem.

The *v0ingest*, *reali_ep*, and *reals_ep* process control scripts are executed automatically. The *v0ingest* script is invoked by the UNIX cron utility (see Section 5.3). The *reali_ep* and *reals_ep* scripts are called from *v0ingest*. The *v0ingest* script also calls the following executables in sequence until either the process completes or a fatal error occurs: *v0ingest.exe*, *v0p4c.exe*, *v0iqc.exe* or *v0sqc.exe*, *v0invent.exe*, *playhis.exe*, and *noaa_volcano* (if processing an Instrument Level 0 file). The *reali_ep* script calls *v0p4c.exe* and *v0imkorb.exe*. The *reals_ep* script calls *v0sstrip.exe* and *v0ssubqc.exe*.

The *v0iqc*, *v0imkorb*, *v0sqc*, and *v0sstrip* process control scripts can be executed for standalone execution of the *v0iqc.c*, *v0imkorb.c*, *v0sqc.c*, and *v0sstrip.c* programs. The Operator Menu Interface (see Section 5.5.3.2) includes calls to these scripts. The *reali_ep* script can also be called from the Operator Menu Interface to restart near real-time processing at the file QC step (step 1) or at the step where orbital files are created from the playback files (step 2). The Operator Menu Interface also includes calls to t~~Except for *v0imkorb.c* and *playhis.c* this software is normally executed only during near real-time processing. The *voimkorb.c* and *playhis.c* programs are first executed for near real-time processing using predictive ephemeris then rerun after definitive ephemeris becomes available. T~~he *v0idump.c*, *v0sdump.c*, and *v0ssubdump.c* programs. These programs are typically used only to support software maintenance and problem analysis activities.

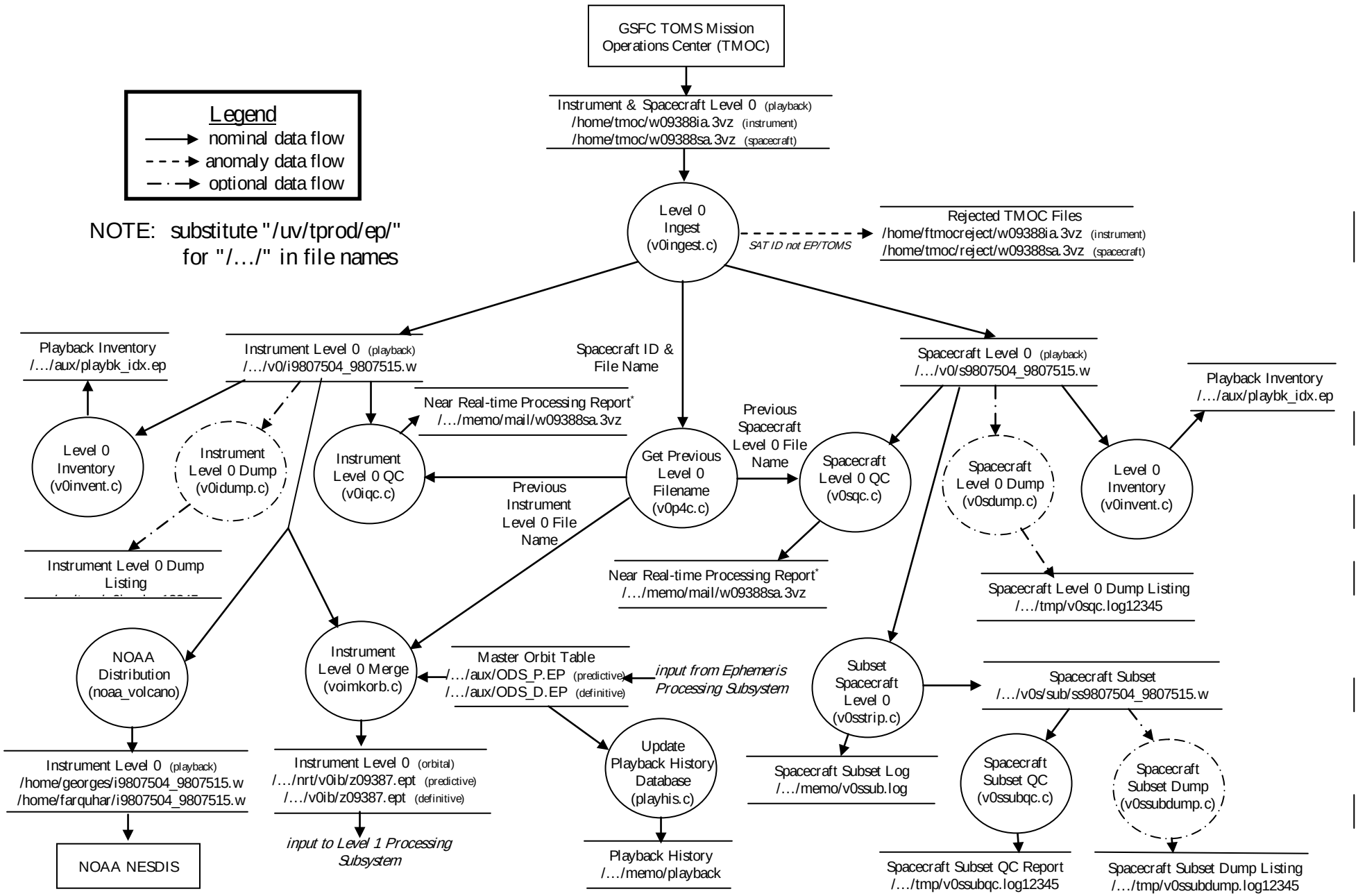
Details of each of the Level 0 ingest programs are in Appendix F. A description of the input Level 0 File is in Appendix A. The output Spacecraft Subset File is described in Appendix B and the orbital Instrument Level 0 File is described in Appendix C. Other data files are described in Appendix D.

### 5.1.3 Auxiliary Subsystem

Figure 5.1.3-1 shows the EP/TOMS Auxiliary Subsystem. Included in this subsystem is 1 C program (*eclipse.c*) that is executed to update the Solar Eclipse File and 2 IDL programs (*fov_const.pro* and *view_angle.pro*) that generate constants that are used in the Level 2 and Level 3 Processing Subsystems. The source of the solar eclipse data is the Astronomical Almanac.

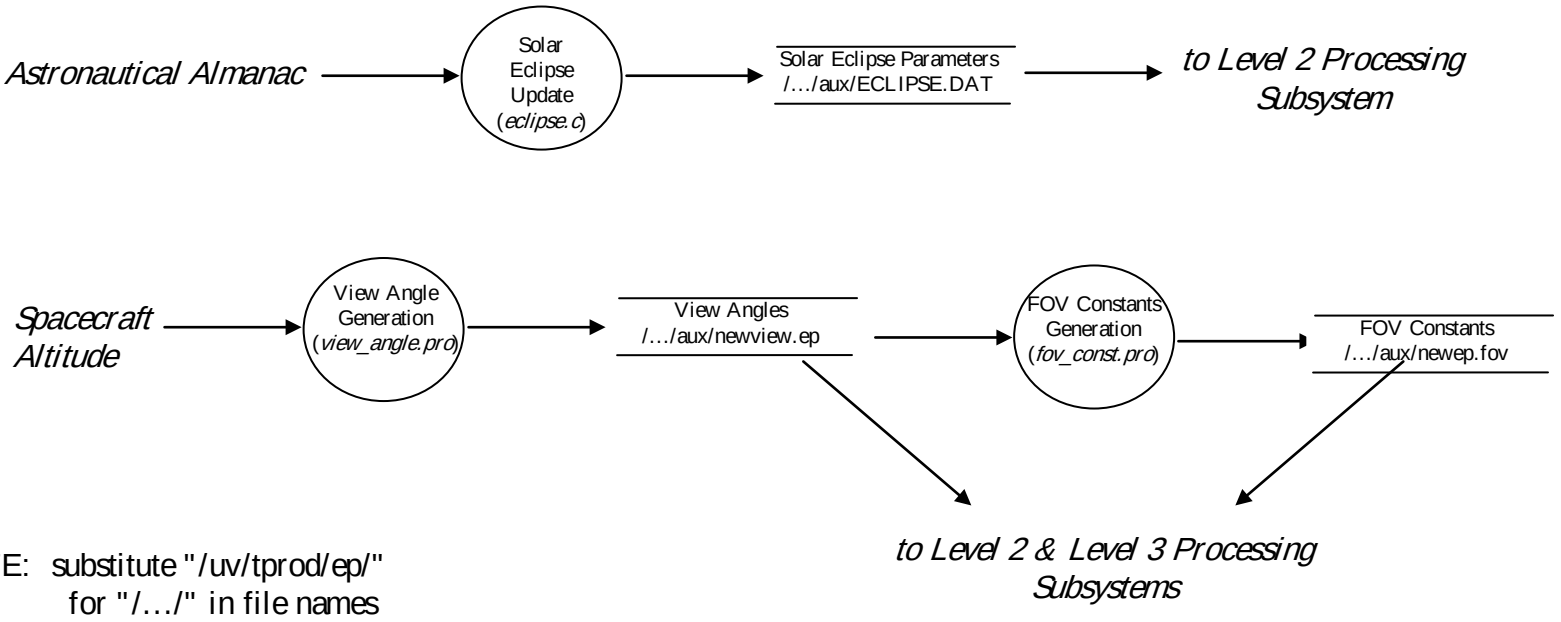
Details of this Auxiliary program are in Appendix G.

# Figure 5.1.2-1
# EP/TOMS Level 0 Ingest Subsystem Data Flow




* QC programs write their reports to standard output; during near real-time processing this standard output is redirected to the Near Real-time Processing Report as

## Figure 5.1.3-1
## EP/TOMS Auxiliary Subsystem Data Flow




NOTE: substitute "/uv/tprod/ep/" for "/.../" in file names

### 5.1.4 Level 1 Processing Subsystem

Figure 5.1.4-1 shows the EP/TOMS Level 1 Processing Subsystem. Level 1 processing uses inputs from the Ephemeris Processing Subsystem (Spacecraft Ephemeris and Orbit Table files) and from the Level 0 Ingest Subsystem (Instrument Level 0 files). Output from this subsystem is used in Level 2 file generation. No Level 1 files are distributed to external users, however, instrument performance analysis uses the Level 1 products as a primary data source.

There are 10 C programs (*rufgencom.c, rufgen.c, ruf_dump.c, rufqccom.c, rufqc.c, rufsub_up.c, rufabs_dump.c, rufcal_dump.c, rufhk_dump.c* and *rufinst_dump.c*) in this subsystem. This software is invoked and controlled by process control scripts (see Section 5.3).

Each program (except dump programs) is first executed for near real-time processing using predictive ephemeris then rerun after definitive ephemeris becomes available. The *ruf_dump.c*, *rufabs_dump.c*, *rufcal_dump.c*, *rufhk_dump.c*, and *rufinst_dump.c* programs are typically used only to support software maintenance and problem analysis activities.

Details of each of the Level 1 processing programs are in Appendix H.

### 5.1.5 Calibration Subsystem

Figure 5.1.5-1 shows the EP/TOMS Calibration Subsystem. Level 1 files are the primary input to the Calibration Subsystem. Output from this subsystem is used in Level 2 file generation. Updated Albedo Correction Files are distributed to NOAA NESDIS from this subsystem.

There are 4 FORTRAN programs (*ivpdr.f, acfgen.f, acffill.f,* and *acfdump.f*), 1 C program (*ivprod.c*), and 2 IDL programs (*degrade.pro* and *acfplt.pro*) in this subsystem. Calibration Subsystem software is invoked and controlled by process control scripts (see Section 5.3). The process control script for *acfgen.f* (*/uv/tprod/ep/bin/acfgen*) performs a UNIX copy (*'cp'*) to copy the updated Albedo Correction File to NOAA accessible directories.

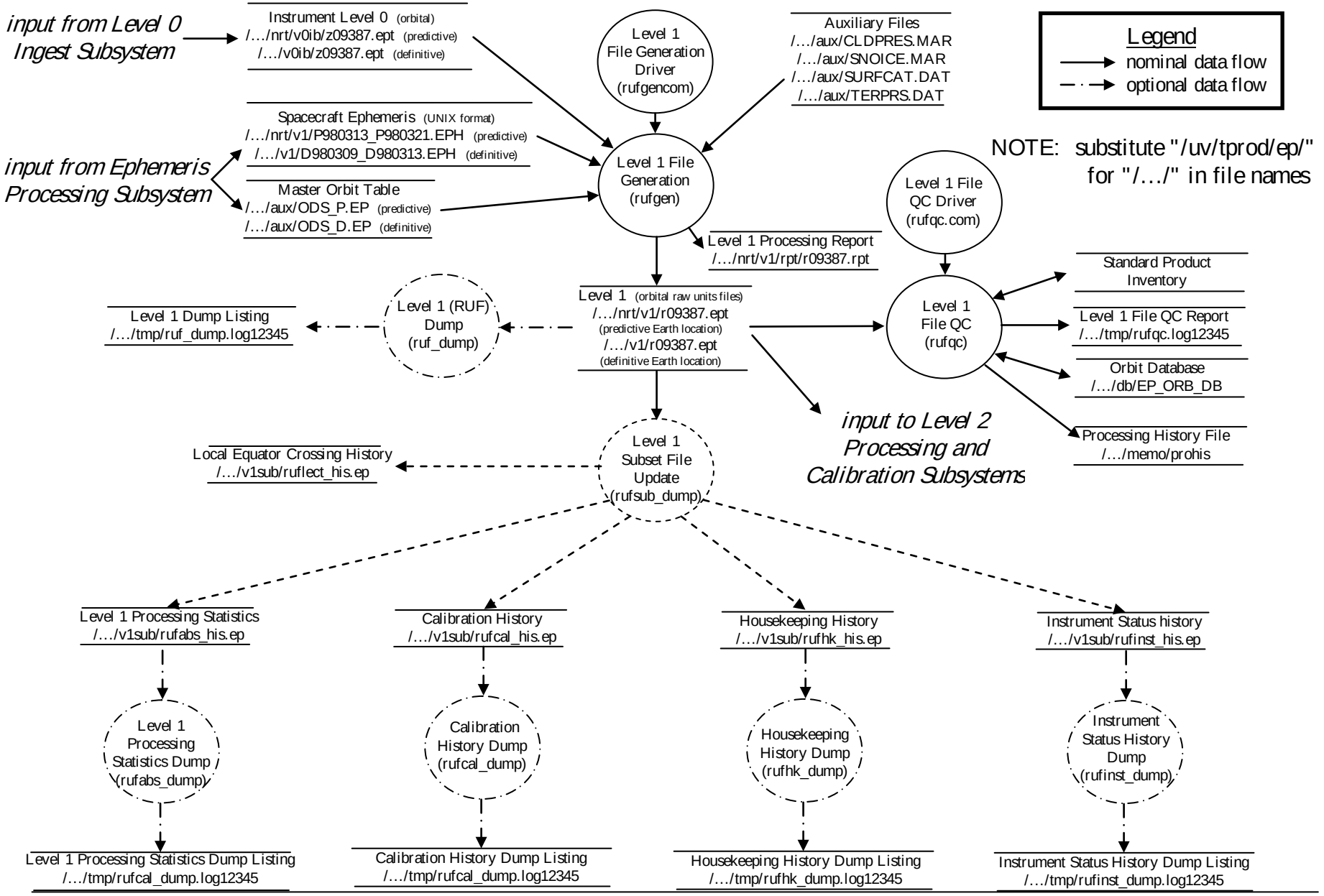
The *acffill.f*, and *acfdump.f* programs are typically used only to support software maintenance and problem analysis activities. The remaining programs are currently scheduled to execute once a week.

Details of the Calibration Subsystem programs are in Appendix I.

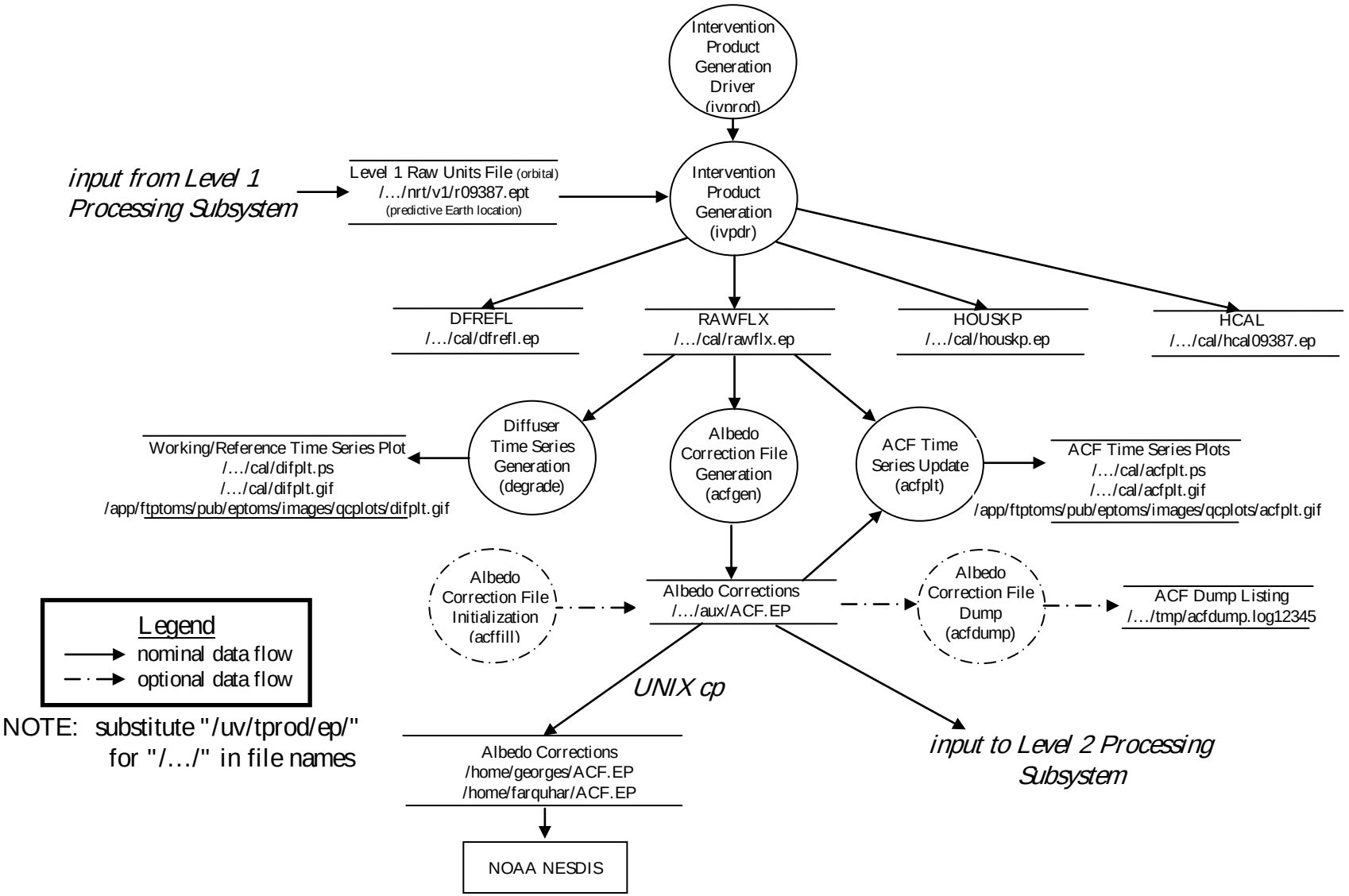
### 5.1.6 Level 2 Processing Subsystem

Figure 5.1.6-1 shows the EP/TOMS Level 2 Processing Subsystem. Level 2 processing uses Level 1 files generated by the Level 1 Processing Subsystem and Albedo Correction Files produced by the Calibration Subsystem as inputs. Output from this subsystem is used in Level 3, Overpass, and Zonal Means file generation. Level 2 data are the primary inputs to data and algorithm validation analysis. Level 2 Standard Product (HDF) files are sent to the GSFC DAAC for archival and distribution to external users.

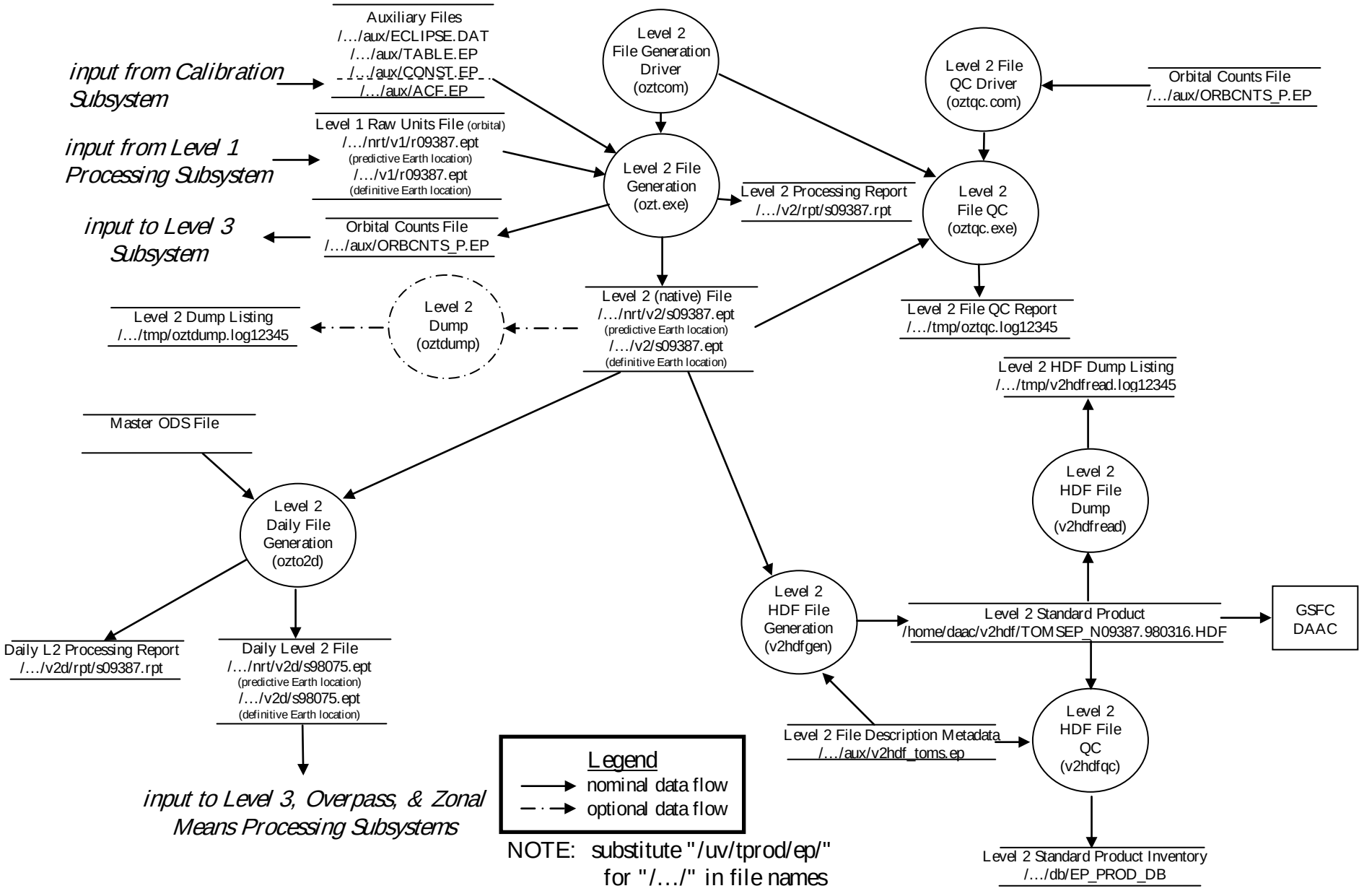
# Figure 5.1.4-1
# EP/TOMS Level 1 Processing Subsystem



## Figure 5.1.5-1
## EP/TOMS Calibration Subsystem Data Flow



## Figure 5.1.6-1
## EP/TOMS Level 2 Processing Subsystem



There are 8 C programs (*oztcom.c, oztdump.c, oztqccom.c, oztqc.c, ozto2d.c, v2hdfgen.c, v2hdfqc.c,* and *v2hdfread.c*) and 1 FORTRAN program (*ozt*) in this subsystem. This software is invoked and controlled by process control scripts (see Section 5.3).

Each program (except *oztdump.c*, *v2hdfgen.c*, *v2hdfqc.c,* and *v2hdfread.c*) is routinely executed for near real-time processing using predictive ephemeris. The *oztdump.c* program is typically used only to support software maintenance and problem analysis activities. The *v2hdfgen.c* and *v2hdfqc.c* programs are only used for generating archival data files.

Details of each of the Level 2 processing programs are in Appendix J.

### 5.1.7 Overpass Processing Subsystem

The Overpass Processing System described in previous versions of this document has been retired. This section in future document revisions will describe the replacement system that is currently under development.

### 5.1.8 Zonal Means Processing Subsystem

Figure 5.1.8-1 shows the EP/TOMS Zonal Means Processing Subsystem. Level 2 Zonal Means processing uses Level 2 files generated by the Level 2 Processing Subsystem. These Level 2 Zonal Means data are used in data and algorithm validation analysis. The inputs for Level 3 Zonal Means processing are Level 3 gridded ASCII files generated by the Level 3 Processing Subsystem. Level 3 Zonal Means files are distributed to the Internet community via the TOMS Web Site.

There are 4 FORTRAN programs (*l3zmdly.f*, *l3zmmly.f, zmtoms.f* and *zmtoms_dump.f*) in this subsystem. This software is invoked and controlled by process control scripts (see Section 5.3).
The *l3zmdly.f* program executes once per day as part of automated near real-time processing. The *l3zmmly.f* program is executed once per month. The *zmtoms.f* program is currently scheduled to execute once per week. The *zmtoms_dump.f* program is used for maintenance.

Details of each of the Zonal Means processing programs are in Appendix L.

### 5.1.9 Level 3 Processing Subsystem

Figures 5.1.9-1 and 5.1.9-2 show the EP/TOMS Level 3 Processing Subsystem. Level 3 processing uses Level 2 files generated by the Level 2 Processing Subsystem as input. Outputs (data, images, and icons) from this subsystem are distributed to the Internet. Level 3 Standard Product (HDF) files are sent to the GSFC DAAC for archival and distributed to external users.

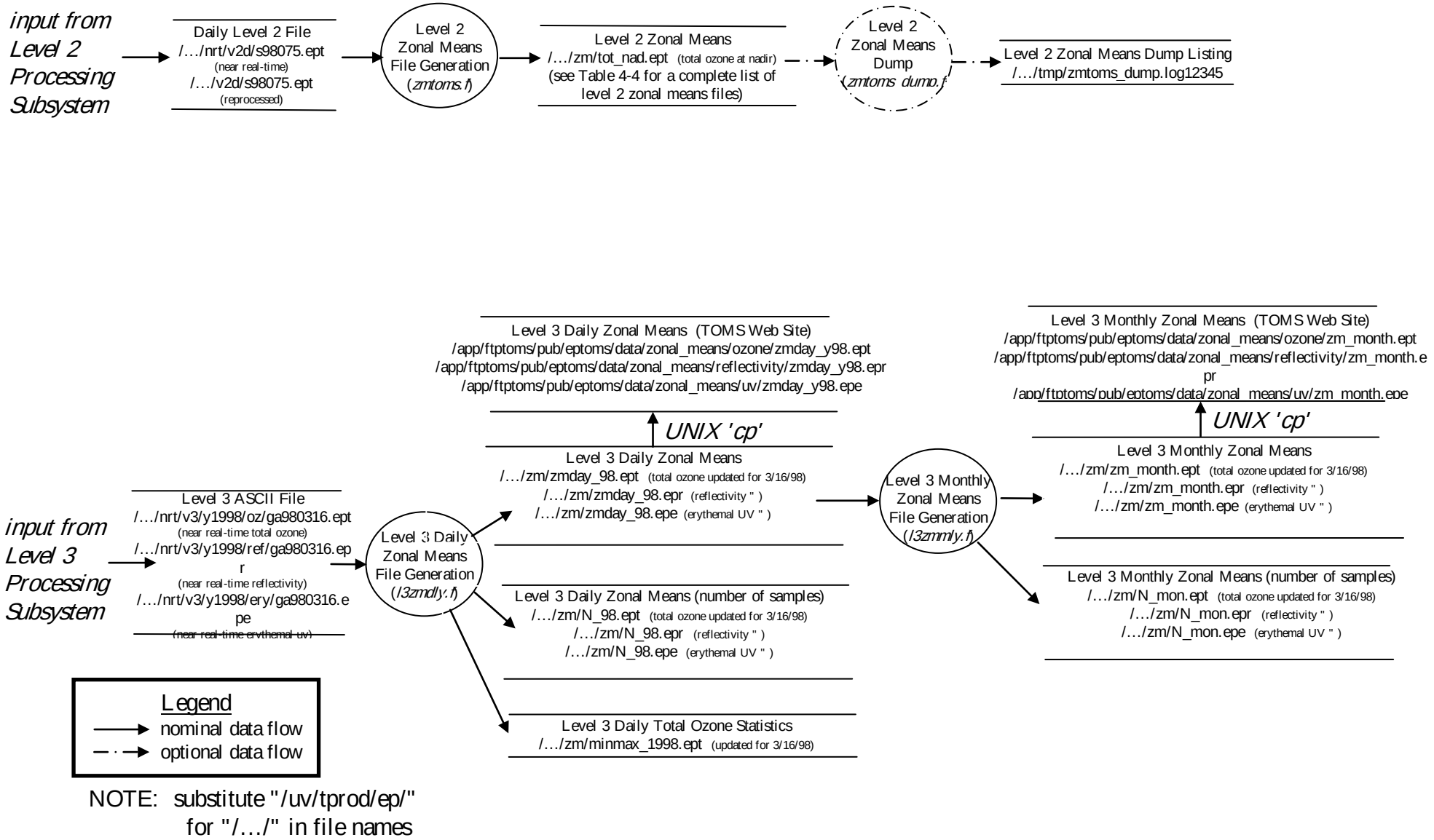
There are 6 C programs (*gridtcom.c, cdtomsqc.c, v3hdfgencom.c, v3hdfgen.c, v3hdfqc.c,* and v3hdfread.c), 2 FORTRAN program (*gridt.f* and *monav.f*), and 6 IDL programs in this subsystem. This software is invoked and controlled by process control scripts (see Section 5.3). Each program (except *monav.f, v3hdfgencom.c*, *v3hdfgen.c*, *v3hdfqc.c,* and

*v3hdfread.c*) is executed for near real-time processing using predictive ephemeris. The *monav.f* program is

## Figure 5.1.7-1
## EP/TOMS Overpass Processing Subsystem

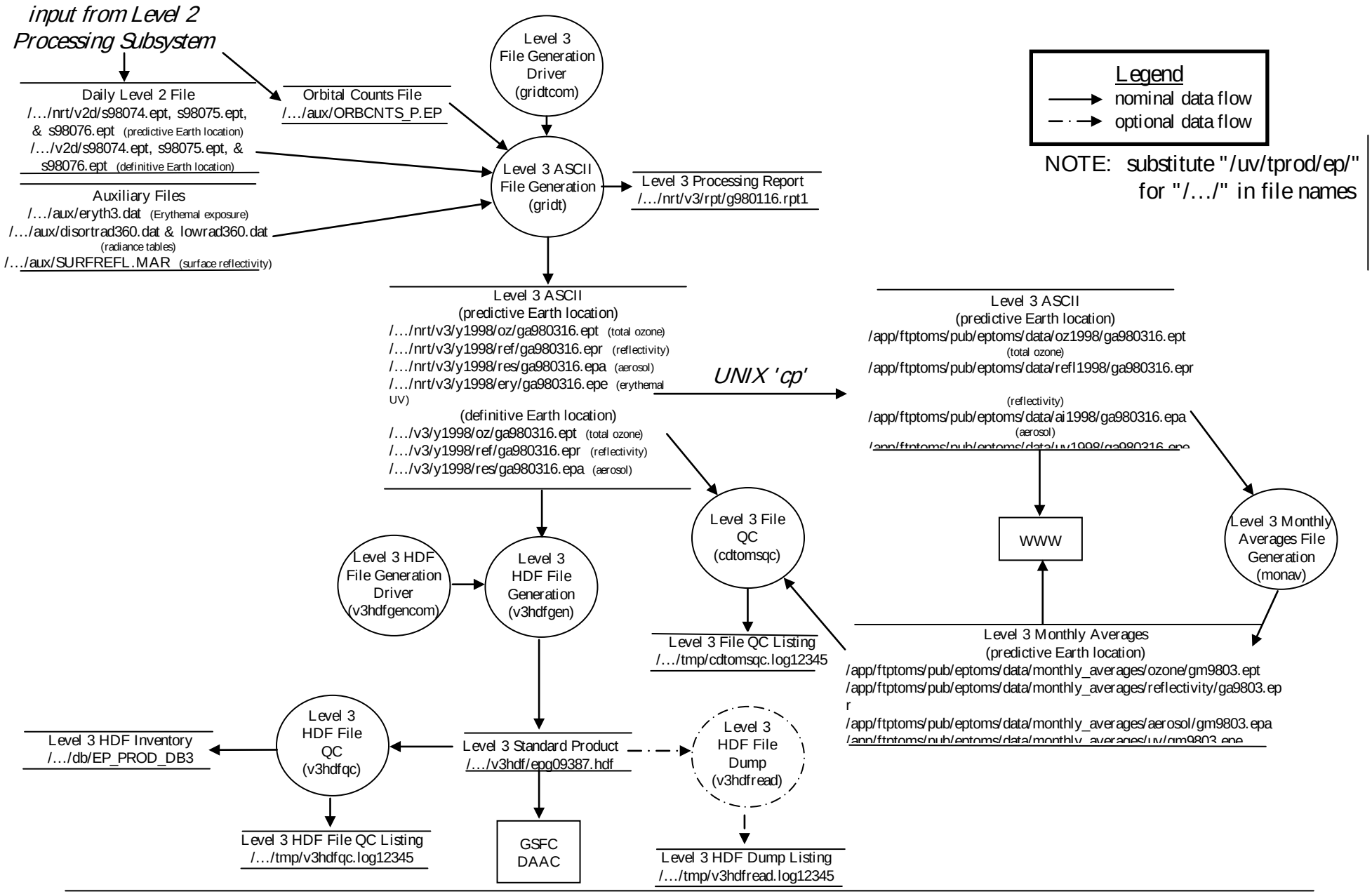
The Overpass Processing System described in previous versions of this document has been retired. ~~This figure in~~F~~ f~~uture document revisions will show the replacement system that is currently under development.~~.~~

# Figure 5.1.8-1
# EP/TOMS Zonal Means Processing Subsystem Data Flow

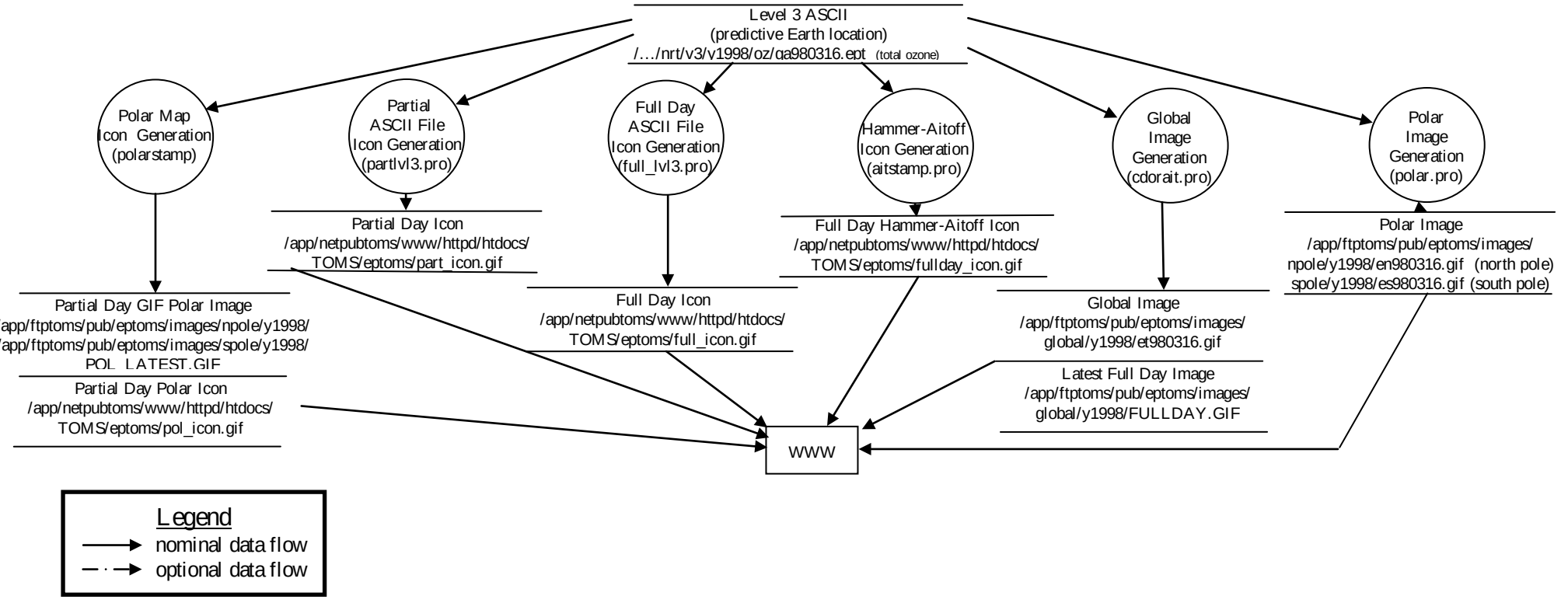



NOTE: substitute "/uv/tprod/ep/" for "/…/" in file names

# Figure 5.1.9-1
# EP/TOMS Level 3 Processing Subsystem – Data File Generation Data Flow



## Figure 5.1.9-2
## EP/TOMS Level 3 Processing Subsystem – Image File Generation




NOTE: substitute "/uv/tprod/ep/" for "/.../" in file names

executed automatically on the second day of each month. The *v3hdfread.c* program is typically used only to support software maintenance and problem analysis activities. The *v3hdfgencom.c, v3hdfgen.c,* and *v2hdfqc.c* programs are only used for generating archival data files.

Details of each FORTRAN and C Level 3 processing programs are in Appendix M.

## 5.2 Software Libraries

EP/TOMS science operations software includes the FORTRAN, C, IDL, and shell script code used to produce, quality check, display, and distribute EP/TOMS science data products. This software resides on GSFC's "*tparty*" workstation in the following directories:

- */uv/tprod/ep/bin/* - UNIX and Perl scripts and FORTRAN and C executables
- */v/tprod/ep/src/* - FORTRAN, C, and IDL (auxiliary file generation) source code
- */uv/tprod/ep/tool/* - shell scripts and IDL source code (product validation and image generation)

An identical set of executable software is also maintained on the backup "*wrabbit*" workstation.

### 5.2.1 Executable Code

Table 5.2.1-1 lists the executable files in */uv/tprod/ep/bin/*. In addition to name and purpose a cross-reference is provided to calling, and called, software. All "Called By" and "Calls To" software is in */uv/tprod/ep/bin/* except for IDL (*.pro) programs. IDL code resides in */uv/tprod/ep/tool/*.

Executable files include user interface scripts, process control scripts, and FORTRAN and C program executables. User interface and process control scripts are generally named for the FORTRAN or C executable that is being invoked. Process control scripts that result in batch processing contain "_bat" or ".bat" in their file names. FORTRAN and C code executables follow a "*.com" or "*.exe" file naming convention. "*.com" indicates a C driver program for a corresponding FORTRAN processing program.

The shell scripts and IDL programs in */uv/tprod/ep/tool/* are used for the generation of product validation products and image products. The contents of */uv/tprod/ep/tool/* are listed in Table 5.2.1-2.

### 5.2.2 Source Code

The EP/TOMS Science Data Processing System's source code is stored in a hierarchy of subdirectories under */uv/tprod/ep/src/*. The first level in this hierarchy is a subsystem or library. EP/TOMS science data processing subsystems include:

- *aux* - generate or dump auxiliary data
- *cal* - initialize, generate, or dump calibration data
- *eph* - ingest, reformat, QC, or dump spacecraft ephemeris data
- *ovp* - initialize or generate overpass data
- *v0* - ingest, QC, subset, or dump Level 0 data

# Table 5.2.1-1
# EP/TOMS Executables
*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| acfdump | acfdump.exe user interface | command line entry | acfdump.exe, toms_banner, toms_hold, toms_run |
| acfdump.exe | dump Albedo Correction File | acfdump | see Appendix I |
| acffill | acffill.exe user interface | command line entry | acffill.exe, toms_banner, toms_hold, toms_run |
| acffill.exe | initialize Albedo Correction File | acffill | see Appendix I |
| acfgen | acfgen.exe user interface | acfgen_main, ivprod_bat | acfgen.exe |
| acfgen.exe | generate Albedo Correction File | acfgen | see Appendix I |
| acfgen_main | user interface for updating predictive ACF | ivprod_main | acfgen, toms_banner, toms_hold, toms_run |
| arch_main | user interface for data backup | toms_menu | jdstr.exe, toms_banner, toms_hold, toms_run, backup_eph, backup_vz |
| backup_eph | backup ephemeris data | backup_eph_bat | jd2ymd.exe |
| backup_eph_bat | batch ephemeris data backup | cron | backup_eph, jdstr.exe |
| backup_vz | backup level 0 data | backup_vz_bat | jd2ymd.exe, jdstr.exe |
| backup_vz_bat | batch level 0 data backup | cron (see Section 5.3.1) | backup_vz, jdstr.exe |
| cdclim.bat | batch generation of ozone or reflectivity vs. climatology plots | command line entry: *cdclim.bat spacecraft_short_id tag start_year start_day end_year end_day data_type level_3_dir [output_dir]* | cdclimoz.pro, cdclimref.pro, jd2ymd.exe |
| cdorimag | user Interface for generating daily/monthly Level-3 ozone maps | toms_menu | cdorimag.bat, fulldaymap.bat, jdstr.exe, polmap.bat, toms_banner, toms_hold, toms_run, ymd2jd.exe, cdormonmain |
| cdorimag.bat | batch process image files for a range of days | cdorimag | cdorimag.pro, jd2ymd.exe |
| cdormon.bat | batch processing for a range of month | cdormonmain | cdormon.pro |
| cdormonmain | user interface for generating monthly Level-3 maps | cdorimag | cdormon.bat, toms_banner, toms_hold, toms_run |
| cdtomsqc.exe | QC Level-3 ASCII File | cdtomsqc, gridt.com | see Appendix M |
| ckv0ssub | verify EP/TOMS spacecraft data subset | | jdstr.exe |
| diffdoy.exe | print the difference between 2 dates | ephingest | see Table 5.2.2-4 |
| eclipse | user interface to create/update solar eclipse file | toms_menu | eclipse.exe, jdstr.exe, toms_banner, toms_hold, toms_run |
| eclipse.exe | create/update solar eclipse file | eclipse | see Appendix G |
| ep | entry into the EP/TOMS science data processing system | tomsd | toms_hold, toms_menu |
| eph_bridge.exe | reformat FDF EPHEM dates | ephingest | see Appendix E |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

(continued on next page)

**Table 5.2.1-1** (continued from previous page)

## EP/TOMS Executables

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| eph_dump | user interface to dump (FDF EPHEM) ephemeris data | toms_menu | eph_dump.exe, jdstr.exe, toms_banner, toms_hold, toms_run |
| eph_dump.exe | dump spacecraft ephemeris (FDF EPHEM format) | eph_dump | see Appendix E |
| eph_pre | user interface for generating predicted ephemeris data | toms_menu | ephqc, fdf, tleget_main, toms_banner, toms_hold |
| ephingest | ingest spacecraft ephemeris data | cron (see Section 5.3.1), ephingest_main | ephingest.exe, ephqc.com, jd2ymd.exe, diffdoy.exe, noaa_volcano, odsmerg.exe, reblk_fmt_i2u.exe, eph_bridge.exe, ymd2jd.exe |
| ephingest.exe | verify ephemeris type and satellite ID | ephingest | see Appendix E |
| ephingest_main | user interface to ingest ephemeris files | toms_menu | ephingest, toms_banner, toms_hold, toms_run |
| ephqc | user interface for ephemeris data QC | eph_pre, toms_menu | ephqc.com, jdstr.exe, toms_banner, toms_hold, toms_run |
| ephqc.com | driver for program which performs quality checks (continuity, orbit period, etc.) on ephemeris and prepares a table of orbit start times | ephingest, ephqc | ephqc.exe |
| ephqc.exe | performs quality checks (continuity, orbit period, etc.) on ephemeris and prepares a table of orbit start times | ephqc.com | see Appendix E |
| fdf | user interface for converting predicted ascii ephemeris data | eph_pre | fdf.com, toms_banner, toms_hold, toms_run |
| fdf.com | driver for program that converts predicted ascii ephemeris data | fdf | fdf.exe |
| fdf.exe | convert predicted ascii ephemeris data | fdf.com | |
| fulldaymap.bat | batch process full day images for a range of days | cdorimag | cdorait.pro, jd2ymd.exe |
| grid.bat | generate Level-3 ASCII files in background | reali_ep | gridt.com |
| gridt | user interface for Level-3 production | toms_menu | gridt.com, jdstr.exe, ozto2dmain, toms_banner, toms_hold, toms_run |
| gridt.com | driver for Level-3 processing | grid.bat, gridt, reali_ep | gridt.exe |
| gridt.exe | generate Level-3 ASCII files | gridt.com | see Appendix M |
| ivpdr.exe | generate intervention (i.e. calibration) products | ivprod | see Appendix I |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

## EP/TOMS Executables

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| ivprod | run intervention program | ivprod_main, ivprod_bat | ivpdr.exe, ivprod.com |
| ivprod.com | build intervention program input parameter file | ivprod | ivpdr.exe |
| ivprod_bat | background production of intervention products followed by update to ACF file | cron (see Section 5.3.1) | acfgen, acfplt.pro, degrade.pro, ivprod, jdstr.exe,odsd2o.exe |
| ivprod_main | user interface for intervention program | toms_menu | acfgen_main, ivprod, jdstr.exe, toms_banner, toms_hold, toms_run |
| jd2ymd.exe | given a Julian date, returns a year, month and day of month | backup_eph, backup_vz, cdclim.bat, cdorimag.bat, ephingest, fulldaymap.bat, lev0i1main, polmap.bat, real_image | see Table 5.2.2-4 |
| jdstr.exe | convert an integral number into an n-character string (prefixed with 0 if not fully filled) | arch_main, backup_eph_bat, backup_vz, backup_vz_bat, ckv0ssub, cdorimag, cdtomsqc, eclipse, eph_dump, ephqc, gridt, ivprod_bat, ivprod_main, lev0i1, noaa_volcano2, ozt, ozt_dump, ozto2d, ozto2dmain, oztqc, oztrun, reali_ep, realimain, ruf_dump, rufgen, rufqc, rufsub_up, v0idump, v0iqc, v0sqc, v2hdfgen.sh, v2hdfqc.sh, v3hdfqc.pl, zmtoms, zmtoms_main | see Table 5.2.2-4 |
| l3zmdly.exe | generate Daily Level 3 Zonal Means files | reali_ep | |
| l3zmmly | driver for Monthly Level 3 Zonal Means | cron (see Section 5.3.1) | l3zmmly.exe |
| l3zmmly.exe | generate Monthly Level 3 Zonal Means | l3zmmly | |
| l3zmqc | generate Zonal Means QC plots | reali_ep | l3zmqc.pro, l3zmqc_icon.pro |
| lectdmp.exe | dump LECT from orbital counts file | command line entry: *lectdmp.exe* | |
| lev0i1 | process Level 0 | lev0i1main | jdstr.exe, rufgen.com, rufqc.bat, v0imkorb.exe, v0p4c.exe, ymd2jd.exe |
| lev0i1main | User interface for processing Level 0 | toms_menu | jd2ymd.exe, lev0i1, toms_banner, toms_hold, toms_run |
| mirror | maintain mirror systems on 'tparty' and 'wrabbit' | cron (see Section 5.3.1) | mirror |
| monav | generate Level 3 Monthly Averages Files | cron (see Section 5.3.1) | monav.exe |
| monav.exe | generate Level 3 Monthly Averages Files | monav | see Appendix M |
| mycron | cron table entries | N/A | |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| nextncday.exe | print the given date + n days | command line entry: *nextncday.exe year month day day_count* | |
| nextnjday.exe | print the given date + n days | command line entry*: nextnjday.exe year julian_day day_count* | |
| noaa_volcano | copy files to NOAA's directory | ephingest, v0ingest | |
| noaa_volcano2 | copy Level 2 files to NOAA directory | reali_ep | jdstr.exe |
| odsd2o.exe | return starting and ending orbit numbers of a given date | ivprod_bat | see Table 5.2.2-4 |
| odsmerg | update Master Orbit Dataset | toms_menu | odsmerg.exe, toms_banner, toms_hold, toms_run |
| odsmerg.exe | update Master Orbit Dataset | ephingest, odsmerg | see Appendix E |
| odso2d.exe | return start date & time of a given orbit number(s) | reali_ep | see Table 5.2.2-4 |
| odsorb.exe | return an orbit number for a given a date and time given | command line entry*: odsorb.exe –option Year [month] day time* | see Table 5.2.2-4 |
| orbcnts.exe | check orbital counts file | command line entry: *orbcnts.exe spacecraft_id –d\|-o\|-f <yeardoy\|orbit\|file>y* | |
| orbit | given orbit number return date or given date return orbit numbers | *command line entry (see online usage for detailed information)* | |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| ozhis | user Interface for generating Level-2 Quality Flag Plots | tomsi | ozhis.bat, toms_banner, toms_hold, toms_run |
| ozhis.bat | batch processing of ozone quality for a range of years | ozhis | ozhis.pro |
| ozt | user interface for Level-2 production | toms_menu | jdstr.exe, ozt.com, ozt_smp, toms_banner, toms_hold, toms_run |
| ozt.com | driver for Level 2 processing (ozt) | ozt, ozt_smp, reali_ep | ozt.exe, oztqc.exe |
| ozt.exe | generate Level 2 native format file | ozt.com, oztrun | see Appendix J |
| ozt_dump | user interface for dumping Level-2 data in report form | toms_menu | jdstr.exe, ozt_dump.exe, toms_banner, toms_hold, toms_run |
| ozt_dump.exe | dump Level 2 (native) File | ozt_dump | see Appendix J |
| ozt_smp | perform Level 2 processing for a list of orbits | ozt | ozt.com |
| oztcmp.exe | compare Level 2 files | *command line entry* | see Appendix J |
| ozto2d | make Level-2 daily file from orbital files | ozto2dmain | jdstr.exe, ozto2d.exe |
| ozto2d.exe | build Daily Level 2 File | ozto2d, reali_ep | see Appendix J |
| ozto2dmain | user Interface for merging Level-2 from orbital into daily file | gridt | jdstr.exe, ozto2d, toms_banner, toms_hold, toms_run |
| oztqc | user Interface for Level-2 (native) file QC | toms_menu | jdstr.exe, oztqc.com, toms_banner, toms_hold, toms_run, ozt.com |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

## EP/TOMS Executables

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| oztqc.com | driver for Level 2 (native) file QC | oztqc | see Appendix J |
| oztqc.exe | perform a product QC check on Level 2 (native) files | drn_rcn, qcmodata, ozt.com | see Appendix J |
| oztrun | driver for ozt.exe | *command line entry* | jdstr.exe, ozt.exe |
| pingnode | test an FTP node | *command line entry* | |
| playhis.exe | update playback history database | v0ingest | see Appendix F |
| polmap.bat | generate polar image files | cdorimag | jd2ymd.exe, polar.pro |
| real_image | batch production of Level-3 image files | reali_ep | jd2ymd.exe, aitstamp.pro, cdorait.pro, full_lvl3.pro, part_lvl3.pro, polar.pro, polarstamp.pro |
| reali_ep | processing of instrument Level 0 data | realimain, v0ingest | grid.bat, gridt.com, jdstr.exe, l3zmdly.exe, l3zmqc, noaa_volcano2, real_image, rufgen.com, ozt.com, ozto2d.exe, v0imkorb.exe, v0invent.exe, v0iqc.exe, v0p4c.exe, zmtoms_bat |
| realimain | User interface for processing near realtime data | toms_menu | jdstr.exe, reali_ep, toms_banner, toms_hold, toms_run |
| reals_ep | processing of spacecraft Level 0 data | v0ingest | v0p4c.exe, v0sstrip.exe, v0ssubqc.exe |
| reblk_fmt_i2u.exe | reformat EPHEM from IBM to UNIX | ephingest | see Appendix E |
| ruf_dump | user interface for dumping RUF data in report format | toms_menu | jdstr.exe, ruf_dump.exe, toms_banner, toms_hold, toms_run |
| ruf_dump.exe | dump Level 1 File | ruf_dump | see Appendix H |
| rufabs_dump.exe | dump Level 1 Processing Statistics File | rufsub_dump | see Appendix H |
| rufcal_dump.exe | dump Calibration Subset File | rufsub_dump | see Appendix H |
| rufcal_skim | user interface for extracting daily data from RUF History Subset | toms_menu | rufcal_skim.exe, toms_banner, toms_hold, toms_run |
| rufcal_skim.exe | extract data from RUF history subset | rufcal_skim | see Appendix H |
| rufgen | user interface for Level-1 production | toms_menu | jdstr.exe, rufgen.com, toms_banner, toms_hold, toms_run |
| rufgen.com | driver for Level-1 processing program | lev0i1, reali_ep, rufgen | rufgen.exe |
| rufgen.exe | generate Level-1 File | rufgen.com | see Appendix H |
| rufhk_dump.exe | dump Housekeeping History File | rufsub_dump | see Appendix H |
| rufinst_dump.exe | dump Instrument Status History File | rufsub_dump | see Appendix H |
| rufqc | user interface for Level-1 file QC | toms_menu | jdstr.exe, rufqc.com, toms_banner, toms_hold, toms_run |
| rufqc.bat | batch Level-1 QC | lev0i1 | rufqc.com |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| rufqc.com | driver for Level-1 file QC | rufqc, rufqc.bat | rufqc.exe |
| rufqc.exe | perform QC checks on Level-1 file | rufqc.com | see Appendix H |
| rufsub_dump | dump RUF history subset | toms_menu | rufcal_dump.exe, rufhk_dump.exe, rufinst_dump.exe, toms_banner, toms_hold, toms_run, rufabs_dump |
| rufsub_up | update RUF History Subsets | rufsub_upmain | jdstr.exe, rufsub_up.exe |
| rufsub_up.exe | generate RUF history subset | rufsub_up | see Appendix H |
| rufsub_upmain | user interface for updating RUF History Subsets | toms_menu | rufsub_up, toms_banner, toms_hold, toms_run |
| scanorb.exe | verify that the number of scans in a file is consistent with the Orbital Counts File | v2hdfqc.sh | see Table 5.2.2-4 |
| tleext.pl | extract the next 2 lines from a 2-line element set given a pattern (s/c name) | tleget | |
| tleget | logon to NORAD's archive ftp site to get tle.new (i.e. the newest two-line element set), and extract its two lines | tleget_main | tleext.pl |
| tleget_main | user interface to get two-line element set | eph_pre | tleget, toms_banner, toms_hold, toms_run |
| toms | psuedo-driver of TOMS processing system | *command line entry* | tomsd, tomsi (through call to /uv/tprod/toms) |
| toms_banner | called by various shell scripts to display the banner on screen | acfdump, acffill, acfgen_main, arch_main, cdorimag, cdormonmain, cdtomsqc, eclipse, eph_dump, eph_pre, ephingest_main, ephqc, fdf, gridt, ivprod_main, lev0i1main, odsmerg, ozhis, ozt, ozt_dump, ozto2dmain, oztqc, realimain, ruf_dump, rufcal_skim, rufgen, rufqc, rufsub_dump, rufsub_upmain, tleget_main, toms_menu, tomsd, tomsi, v0idump, v0imkorb, v0ingest_main, v0iqc, v0sdump, v0sqc, v0sstrip, v2hdfgen, v2hdfqc, v3hdfgen, v3hdfqc, zmtoms_main | toms_pr_banner.exe, toms_hold |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| toms_hold | hold the screen until user presses any key | acfdump, acffill, acfgen_main, arch_main, cdorimag, cdormonmain, cdtomsqc, eclipse, ep, eph_dump, eph_pre, ephingest_main, ephqc, fdf, gridt, ivprod_main, lev0i1main, odsmerg, ozhis, ozt, ozt_dump, ozto2dmain, oztqc, realimain, ruf_dump, rufcal_skim, rufgen, rufqc, rufsub_dump, rufsub_upmain, tleget_main, toms_banner, toms_menu, tomsd, tomsd_access, v0idump, v0imkorb, v0ingest_main, v0iqc, v0sdump, v0sqc, v0sstrip, v2hdfgen, v2hdfqc, v3hdfgen, v3hdfqc, zmtoms_main | |
| toms_menu | EP/TOMS science data processing system | ep | ephqc, lev0i1main, odsmerg, ozt, oztqc, ozt_dump, realimain, ruf_dump, rufgen, rufqc, rufsub_upmain, toms_banner, v0idump, v0imkorb, v0iqc, v0sdump, v0sqc, v0sstrip, v2hdfgen, v2hdfqc, v3hdfgen, v3hdfqc, zmtoms_main, toms_hold, v0ingest_main, eph_pre, eph_dump, gridt, ivprod_main, cdorimag, cdtomsqc, arch_main, rufsub_dump |
| toms_pr_banner.exe | display the banner on screen | toms_banner | |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| toms_run | run executable in a specified time | acfdump, acffill, acfgen_main, arch_main, cdorimag, cdormonmain, cdtomsqc, eclipse, eph_dump, ephingest_main, ephqc, fdf, gridt, ivprod_main, lev0i1main, odsmerg, ozhis, ozt, ozt_dump, ozto2dmain, oztqc, realimain, ruf_dump, rufcal_skim, rufgen, rufqc, rufsub_dump, rufsub_upmain, tleget_main, v0idump, v0imkorb, v0ingest_main, v0iqc, v0sdump, v0sqc, v0sstrip, v2hdfgen, v2hdfqc, v3hdfgen, v3hdfqc, zmtoms_main | |
| tomsd | driver for the TOMS science data processing system | ep, toms | adeos, ep, meteor3, nimbus7, toms_banner, toms_hold, tomsd_access |
| tomsd_access | control access to the TOMS science processing system | tomsd | toms_hold |
| tomsi | driver for the TOMS image processing system | toms | ozhis, toms_banner |
| v0idump | user interface for dumping Level-0 instrument data | toms_menu | jdstr.exe, toms_banner, toms_hold, toms_run, v0idump.exe |
| v0idump.exe | dump Instrument Level 0 File | v0idump | see Appendix F |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| v0imkorb | user interface for building Level-0 instrument data files | toms_menu | toms_banner, toms_hold, toms_run, v0imkorb.exe |
| v0imkorb.exe | build orbital instrument Level 0 files | lev0i1, reali_ep, v0imkorb | see Appendix F |
| v0ingest | ingest Level 0 data | v0ingest_main | noaa_volcano, playhis.exe, reali_ep, reals_ep, v0ingest.exe, v0iqc.exe, v0sqc.exe, v0invent.exe, v0p4c.exe, v0sqc.exe |
| v0ingest.exe | verify instrument Level 0 product type and satellite ID | v0ingest | see Appendix F |
| v0ingest_main | user interface for verifying L0 product type and satellite ID | toms_menu | toms_banner, toms_hold, toms_run, v0ingest |
| v0invent.exe | inventory instrument Level 0 data | reali_ep, v0ingest | see Appendix F |
| v0iqc | user interface for Level-0 instrument file QC | toms_menu | jdstr.exe, toms_banner, toms_hold, toms_run, v0iqc.exe |
| v0iqc.exe | check format and content of instrument Level 0 file | reali_ep, v0ingest, v0iqc | see Appendix F |
| v0p4c.exe | determine name of previous instrument Level 0 file | lev0i1, reali_ep, reals_ep, v0ingest | see Appendix F |
| v0sdump | dump S/C Level 0 | toms_menu | toms_banner, toms_hold, toms_run, v0sdump.exe, v0ssubdump.exe |
| v0sdump.exe | dump S/C Level 0 | v0sdump | see Appendix F |
| v0sqc | QC S/C Level 0 | toms_menu | jdstr.exe, toms_banner, toms_hold, toms_run, v0sqc.exe, v0ssubqc.exe |
| v0sqc.exe | QC S/C Level 0 | v0ingest, v0sqc | see Appendix F |
| v0sstrip | user interface to subset S/C Level 0 | toms_menu | toms_banner, toms_hold, toms_run, v0sstrip.exe |
| v0sstrip.exe | subset S/C Level 0 | reals_ep, v0sstrip | see Appendix F |
| v0ssubdump.exe | dump S/C subset | v0sdump | see Appendix F |
| v0ssubqc.exe | QC S/C subset | reals_ep, v0sqc | see Appendix F |
| v2hdfgen | user interface for generating Level 2 Standard Product (HDF) files from Level-2 (orbital) files | toms_menu | toms_banner, toms_hold, toms_run, v2hdfgen.sh |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

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**Table 5.2.1-1** (continued from previous page)

**EP/TOMS Executables**

*(/uv/tprod/ep/bin/)*

| File Name | Purpose | Called By[1] | Calls To[1] |
|---|---|---|---|
| v2hdfgen.exe | generate Level 2 Standard Product (HDF) files | v2hdfgen.sh | see Appendix J |
| v2hdfgen.sh | generate Level 2 Standard Product (HDF) files from Level-2 (orbital) files | v2hdfgen | jdstr.exe, scanorb.exe, v2hdfgen.exe |
| v2hdfqc | user interface for QC Level-2 HDF | toms_menu | toms_banner, toms_hold, toms_run, v2hdfqc.sh |
| v2hdfqc.exe | perform QC checks on Level 2 Standard Product (HDF) file | v2hdfqc.sh | see Appendix J |
| v2hdfqc.sh | Level 2 Standard Product (HDF) file QC | v2hdfgen.sh, v2hdfqc | jdstr.exe, v2hdfqc.exe |
| v2hdfread.exe | dump Level 2 HDF files | v2hdfread | see Appendix J |
| v3hdfgen | user interface for generating Level 3 Standard Product (HDF) files | toms_menu | toms_banner, toms_hold, toms_run, v3hdfgen.com |
| v3hdfgen.com | driver for Level 3 Standard Product (HDF) generation | v3hdfgen | v3hdfgen.exe |
| v3hdfgen.exe | generate Level 3 Standard Product (HDF) files | v3hdfgen.com | see Appendix M |
| v3hdfqc | user interface for QC Level-3 HDF | toms_menu | toms_banner, toms_hold, toms_run, v3hdfqc.pl |
| v3hdfqc.exe | perform QC checks on Level 3 Standard Product (HDF) file | v3hdfqc.pl | see Appendix M |
| v3hdfqc.pl | Level 3 Standard Product (HDF) file QC | v3hdfqc | jdstr.exe, v3hdfqc.exe |
| v3hdfread.exe | read Level 3 HDF files | command line: v3hdfread.exe HDF_directory | see Appendix M |
| ymd2jd.exe | return a Julian date for a given calendar date | cdorimag, ephingest, lev0i1 | see Table 5.2.2-4 |
| zmtoms | update zonal means files | zmtoms_bat, zmtoms_main | jdstr.exe, zmtoms.exe |
| zmtoms.exe | generate zonal means files | zmtoms | see Appendix L |
| zmtoms_bat | batch update of zonal means files | cron (see Section 5.3-1), real_ep | zmtoms |
| zmtoms_dump | dump zonal means file | zmtoms_main | zmtoms_dump.exe |
| zmtoms_dump.exe | dump zonal means files | zmtoms_dump | see Appendix L |
| zmtoms_main | user interface for processing Zonal Means datasets | toms_menu | jdstr.exe, toms_banner, toms_hold, toms_run, zmtoms, zmtoms_dump |

[1]all calling and called executables are in */uv/tprod/ep/bin/* excepts IDL executables (i.e. *.pro) which are in */uv/tprod/ep/tool/*

# Table 5.2.1-2
# EP/TOMS Product Validation & Image Generation Tools
*(/uv/tprod/ep/tool/)*

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| acfplt.pro | update ACF time series plots | /uv/tprod/ep/bin/ivprod_bat | |
| aitstamp | driver for aitstamp.pro | *command line entry* | imageproc |
| aitstamp.pro | generate full day Level 3 Hammer-Aitoff icon | /uv/tprod/ep/bin/real_image, aitstampmenu.pro | |
| aitstampmenu.pro | user interface for aitstamp.pro | imageproc | aitstamp.pro |
| cdclim | driver for cdclimoz.pro and cdclimref.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| cdclimenu.pro | user interface for cdclimoz.pro and cdclimref.pro | imageproc | cdclimoz.pro, cdclimref.pro |
| cdclimoz.pro | produces plot of 180 latitude band ozone statistics over a daily Nimbus-7/TOMS climatology from Level 3 ASCII files | /uv/tprod/ep/bin/cdclim.bat, cdclimmenu.pro | |
| cdclimref.pro | produces plot of 180 latitude band reflectivity statistics over a daily Nimbus-7/TOMS climatology from Level 3 ASCII files | /uv/tprod/ep/bin/cdclim.bat, cdclimmenu.pro | |
| cdl | driver for cdlatqc.pro and cdlonqc.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| cdlatqc.pro | plots ozone vs. latitude for a specified longitude from a Level 3 ASCII file | cdlmenu.pro | |
| cdlmenu.pro | user interface for cdlatqc.pro and cdlonqc.pro | imageproc | cdlatqc.pro, cdlonqc.pro |
| cdlonqc.pro | plots reflectivity vs. latitude for a specified longitude from a Level 3 ASCII file | cdlmenu.pro | |
| cdor | driver for cdorimag.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| cdorait.pro | generate Hammer-Aitoff equal area color image | /uv/tprod/ep/bin/fulldaymap.bat, /uv/tprod/ep/bin/real_image | |
| cdorimag.pro | produces color contour plots of ozone or reflectivity over a set of cylindrical and orthogonal polar projections from a Level 3 ASCII file | /uv/tprod/ep/bin/cdorimag.bat, cdormenu.pro | |

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## Table 5.2.1-2 (continued from previous page)

## EP/TOMS Product Validation & Image Generation Tools

*(/uv/tprod/ep/tool/)*

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| cdormenu.pro | user interface for cdorimag.pro | imageproc | cdorimag.pro |
| cdormon | driver for cdormon.pro | /uv/tprod/ep/bin/tomsi | cdormonmenu.pro |
| cdormon.pro | produces a monthly set of postage stamp total ozone images from a Level 3 ASCII file | /uv/tprod/ep/bin/cdormon.bat, cdormonmenu.pro | |
| cdormonmenu.pro | user interface for cdormon.pro | cdormon | cdormon.pro |
| cdrdiff | driver for cdrdiff.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| cdrdiff.pro | plot reflectivity histogram | cdrdiffmenu.pro | |
| cdrdiffmenu.pro | user interface for cdrdiff.pro | imageproc | cdrdiff.pro |
| dcov | driver for dcov.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| dcov.pro | plots number of scans of Level 2 data vs. time from Level 2 (native) files | dcovmenu.pro | |
| dcovmenu.pro | user interface for dcov.pro | imageproc | dcov.pro |
| degrade.pro | produce working/reference time series plot | ivprod_bat | |
| full_lvl3.pro | generate full day Level 3 ASCII File icon | /uv/tprod/ep/bin/real_image | |
| greenland.pro | plots reflectivity over a Greenland base map. | *command line entry* | |
| imageproc | sub-driver for IDL tools | aitstamp, cdclim, cdl, cdor, cdrdiff, dcov, ozhis, polar, polarstamp, snowice, zmtoms | aitstampmenu.pro, cdclimmenu.pro, cdlmenu.pro, cdormenu.pro, cdrdiffmenu.pro, dcovmenu.pro, ozhismenu.pro, polarmenu.pro, polarstampmenu.pro, snowicemenu.pro, zmtomsmenu.pro |
| l3zmqc.pro | plots total ozone vs. climatology (hemispheric and equatorial averages, SH minimum, ozone hole size) | /uv/tprod/ep/bin/l3zmqc | |
| l3zmqc_icon.pro | plots total ozone vs. climatology icons | /uv/tprod/ep/bin/l3zmqc | |
| nasa.gif | NASA logo (black background) | polar.pro | |
| nasa_logo.gif | NASA logo (white background) | cdorait.pro, cdorimag.pro | |
| ozdmp | driver for ozdmp.pro | /uv/tprod/ep/bin/tomsi | ozdmp.pro |
| ozdmp.pro | plot selected Level 2 data | ozdmp | |

(continued on next page)

## Table 5.2.1-2 (continued from previous page)

## EP/TOMS Product Validation & Image Generation Tools

*(/uv/tprod/ep/tool/)*

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| ozflagqc | driver for ozflagqc.pro | /uv/tprod/ep/bin/tomsi | ozflagqc.pro |
| ozflagqc.pro | plots selected Level 2 quality flags | ozflagqc | |
| ozhis | driver for ozhis.pro | /uv/tprod/ep/bin/ozhis.bat, /uv/tprod/ep/bin/tomsi | imageproc |
| ozhis.pro | plots min & max ozone, error ratios for algorithm flags 1, 2, 3, and 4, and error flag occurence for each algorithm flag vs. time from Level 2 (native) files | ozhismenu.pro | |
| ozhismenu.pro | user interface for ozhis.pro | imageproc | ozhis.pro |
| part_lvl3.pro | generate partial Level 3 ASCII file icon | /uv/tprod/ep/bin/real_image | |
| polar | driver for polar.pro | *command line entry* | imageproc |
| polar.pro | produces color contour plot of ozone over a limited (70S to 90S) polar region from a Level 3 ASCII file | /uv/tprod/ep/bin/polmap.bat, /uv/tprod/ep/bin/real_image, polarmenu.pro | |
| polarmenu.pro | user interface for polar.pro | imageproc | polar.pro |
| polarstamp | driver for polarstamp.pro | *command line entry* | imageproc |
| polarstamp.pro | generate Level 3 polar map icon | /uv/tprod/ep/bin/real_image, polarstampmenu.pro | |
| polarstampmenu.pro | user interface for polarstamp.pro | imageproc | polarstamp.pro |
| polstamp.pro | generate partial day Level 3 polar map icon | *command line entry* | |
| qclvl3.pro | generate monthly "postage stamp" images | *command line entry* | |
| snowice | driver for snowice.pro | /uv/tprod/ep/bin/tomsi | imageproc |
| snowice.pro | plots global map of snow/ice probability for selected month | snowicemenu.pro | |
| snowicemenu.pro | user interface for snowice.pro | imageproc | snowice.pro |
| zmtoms | driver for zmtomslat.pro and zmtomsts.pro | *command line entry* | imageproc |
| zmtomslat.pro | plots selected value from selected scene position vs. latitude from zonal means file | zmtomsmenu.pro | |
| zmtomsmenu.pro | user interface for zmtomslat.pro and zmtomsts.pro | imageproc | zmtomslat.pro, zmtomsts.pro |
| zmtomsts.pro | plots time series of selected value, scene, and latitude band | zmtomsmenu.pro | |

- *v1* - generate, QC, subset, or dump Level 1 data
- *v2* - generate, QC, or dump Level 2 data
- *v3* - generate, QC, or dump Level 3 data
- *zm* - generate or dump zonal means data

EP/TOMS science data processing libraries include:

- *include* - C header files and FORTRAN common block definitions
- */lib* - subprograms that are, or could be, shared by multiple subsystems
- *util* - programs that are called throughout the processing system

Subsystem directories contain program specific subdirectories. Program subdirectories are listed in Table 5.2.2-1. Each program's purpose and MAIN module filename is also identified in Table 5.2.2-1.

Prolog comments are stored in each program subdirectory in a separate file named "prolog_XXX", where XXX is the program's name. These prolog comments list:

- program version number and date,
- program version history,
- original author and modifiers,
- execution procedures and calling arguments,
- inputs and outputs, and
- program structure.

Each program specific subdirectory also includes a README file and a Makefile. The README file documents the contents of subdirectory. The Makefile contains the definitions and instructions required to produce a program executable using the UNIX 'make' utility.

In some cases there are version specific subdirectories established under a program subdirectory. These version subdirectories are named "Version_X.X" where "X.X" denotes program version number. These version specific subdirectories store either past version code or future version code.

In the case of past versions only those modules that were changed or deleted in the subsequent version are stored. In the case of future versions modules that have been modified and/or added are stored. Candidate version prolog, README, and Makefile files are also stored in future version subdirectories. Future version code subdirectories are established when the code is submitted for approval. Submittal occurs only after development and pre-acceptance testing is complete.

The contents of */uv/tprod/ep/src/lib/* are listed in Table 5.2.2-2. Contents of */uv/tprod/ep/include/* and */uv/tprod/ep/util/* are listed in Tables 5.2.2-3 and 5.2.2-4.

## Table 5.2.2-1
## EP/TOMS Science Processing FORTRAN and C Program Source Code

| Subsystem Directory | Program Subdirectory | MAIN Module Location | Purpose | # of modules* | # of lines** |
|---|---|---|---|---|---|
| /uv/tprod/ep/src/aux/ | eclipse/ | eclipse.c | update Solar Eclipse File | 8 | 300 |
| | satfov/ | fov_const.pro | compute FOV constants | 1 | 46 |
| | | view_angle.pro | compute view angles | 1 | 36 |
| /uv/tprod/ep/src/cal/ | acfdump/ | acfdump.f | dump Albedo Correction File | 1 | 53 |
| | acffill/ | acffill.f | initialize Albedo Correction File | 1 | 134 |
| | acfgen/ | acfgen.f | generate Albedo Correction File | TBD | TBD |
| | ivpdr/ | ivpdr.f | generate Intervention Products | TBD | TBD |
| | ivprod/ | ivprod.c | driver for ivpdr | 3 | 194 |
| /uv/tprod/ep/src/eph/ | eph_bridge/ | eph_bridge.c | convert FDF EPHEM dates | 2 | 141 |
| | eph_dump/ | eph_dump.c | dump Spacecraft Ephemeris File | 1 | 108 |
| | ephingest/ | ephingest.c | ingest Spacecraft Ephemeris File | 3 | 130 |
| | ephqc/ | ephqc.f | check ephemeris & build ODS | 43 | 4044 |
| | ephqccom/ | ephqccom.c | driver for ephqc | 3 | 178 |
| | odsmerg/ | odsmerg.c | combine orbit table with Master Orbit Dataset | 5 | 379 |
| | reblk_fmt_i2u/ | reblk_fmt_i2u.f | convert FDF EPHEM from IBM to UNIX format | 2 | 186 |
| /uv/tprod/ep/ovp/ (NOTE: the code stored here is from the Overpass Processing Subsystem that was retired on May 24, 1999) | overpass/ | overpass.f | generate overpass products | 12 | 912 |
| | overpass_all/ | overpass_all.f | generates file w/all Level 2 values | 6 | 396 |
| | overpass_clst/ | overpass_clst.f | generates files w/10 closest overpasses | 2 | 427 |
| | overpass_d2s/ | overpass_d2s.f | converts direct access to ASCII | 2 | 142 |
| | overpass_fill/ | overpass_fill.f | initiate overpass file | 3 | 158 |
| | overpass_ten/ | overpass_ten.f | generates daily 10 closest | 2 | 437 |
| /uv/tprod/ep/src/util/ | diffdoy/ | diffdoy.c | differences 2 dates | 1 | 67 |
| | jd2ymd/ | jd2ymd.c | convert date (YYYY DDD to YYMMDD) | 1 | 51 |
| | jdstr/ | jdstr.c | convert integer to string w/leading 0s | 1 | 61 |
| | odsd2o/ | odsd2o.c | determines orbits in a given date | 1 | 79 |
| | odso2d/ | odso2d.c | determines start date of given orbit | 1 | 75 |
| | odsorb/ | odsorb.c | determine orbit for a given time | 1 | 112 |
| | ymd2jd/ | ymd2jd.c | convert calendar date to julian date | 1 | 51 |

* number of modules does not include library subprograms (/uv/tprod/ep/src/lib, HDF library, compiler supplied functions, UNIX system calls, etc.)

** number of lines is the output from the UNIX "wc -l" command; these are not equivalent to number of executable lines.

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## Table 5.2.2-1 (continued)
## EP/TOMS Science Processing FORTRAN and C Program Source Code

| Subsystem Directory | Program Subdirectory | MAIN Module Location | Purpose | # of modules* | # of lines** |
|---|---|---|---|---|---|
| /uv/tprod/ep/src/v0/ | playhis/ | playhis.c | update Playback History File | 2 | 153 |
| | v0imkorb/ | v0imkorb.c | split Instrument Level 0 files | 3 | 506 |
| | v0ingest/ | v0ingest.c | ingest Level 0 files | 7 | 412 |
| | v0invent/ | v0invent.c | inventory Level 0 files | 3 | 250 |
| | v0iqc/ | v0iqc.c | check Instrument Level 0 files | 8 | 606 |
| | v0idump/ | v0idump.c | dump Instrument Level 0 files | 9 | 405 |
| | v0p4c/ | v0p4c.c | determine previous Level 0 file | 3 | 170 |
| | v0sdump/ | v0sdump.c | dump Spacecraft Level 0 file | 4 | 323 |
| | v0sqc/ | v0sqc.c | check Spacecraft Level 0 files | 5 | 430 |
| | v0sstrip/ | v0sstrip.c | subset Spacecraft Level 0 files | 5 | 328 |
| | v0ssubqc/ | v0ssubqc.c | check Spacecraft Level 0 Subset | 5 | 364 |
| | v0ssubdump/ | v0ssubdump.c | dump Spacecraft Level 0 Subset | 4 | 231 |
| /uv/tprod/ep/src/v1/ | ruf_dump/ | ruf_dump.c | dump Level 1 file | 6 | 346 |
| | rufabs_dump/ | rufabs_dump.c | dump Level 1 processing statistics | 1 | 77 |
| | rufcal_dump/ | rufcal_dump.c | dump Calibration Subset | 1 | 175 |
| | rufhk_dump/ | rufhk_dump.c | dump Housekeeping History File | 1 | 119 |
| | rufinst_dump/ | rufinst_dump.c | dump Instrument Status History File | 1 | 102 |
| | rufgen/ | rufgen.c | generate Level 1 file | 32 | 2641 |
| | rufgencom/ | rufgencom.c | driver for rufgen | 6 | 393 |
| | rufqc/ | rufqc.c | check Level 1 file | 13 | 797 |
| | rufqccom/ | rufqccom.c | driver for rufqc | 2 | 289 |
| | rufsub_up/ | rufsub_up.c | update Level 1 subsets | 2 | 497 |

* number of modules does not include library subprograms (/uv/tprod/ep/src/lib, HDF library, compiler supplied functions, UNIX system calls, etc.)

** number of lines is the output from the UNIX "wc -l" command; these are not equivalent to number of executable lines.

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## Table 5.2.2-1 (continued)
## EP/TOMS Science Processing FORTRAN and C Program Source Code

| Subsystem Directory | Program Subdirectory | MAIN Module Location | Purpose | # of modules* | # of lines** |
|---|---|---|---|---|---|
| /uv/tprod/ep/src/v2/ | ozt/ | ozt.f | generate native Level 2 file | 69 | 13976 |
| | oztcom/ | oztcom.c | driver for ozt | 5 | 447 |
| | oztdump/ | oztdump.c | dump native Level 2 file | 11 | 441 |
| | ozt02d/ | ozto2d.c | build Daily Level 2 File | 2 | 204 |
| | oztqc/ | oztqc.c | check native Level 2 file | 7 | 416 |
| | oztqccom/ | oztqccom.c | driver for oztqc | 2 | 104 |
| | v2hdfgen/ | v2hdfgen.c | generate Level 2 Standard Product | 8 | 1193 |
| | v2hdfqc/ | v2hdfqc.c | check Level 2 Standard Product | 7 | 858 |
| /uv/tprod/ep/src/v3/ | cdtomsqc/ | cdtomsqc.c | check native Level 3 ASCII file | 3 | 451 |
| | gridt/ | gridmain.f | generate native Level 3 ASCII file | 32 | 5604 |
| | gridtcom/ | gridtcom.c | driver for grid | 4 | 256 |
| | monav/ | monav.f | generate Level 3 Monthly Averages | 3 | 458 |
| | v3hdfgen/ | v3hdfgen.c | generate Level 3 Standard Product | 5 | 426 |
| | v3hdfgencom/ | v3hdfgencom.c | driver for v3hdfgen | 6 | 711 |
| | v3hdfqc/ | v3hdfqc.c | check Level 3 Standard Product | 8 | 622 |
| /uv/tprod/ep/src/zm/ | l3zmdly/ | l3zmdly.f | generate Daily Level 3 Zonal Means | 7 | 1023 |
| | l3zmmly/ | l3zmmly.f | generate Monthly Level 3 Zonal Means | 2 | 328 |
| | zmtoms/ | zmtoms.f | generate Zonal Means products | 5 | 997 |
| | zmtoms_dump/ | zmtoms_dump.f | dump Zonal Means products | 1 | 157 |

* number of modules does not include library subprograms (/uv/tprod/ep/src/lib, HDF library, compiler supplied functions, UNIX system calls, etc.)

** number of lines is the output from the UNIX "wc -l" command; these are not equivalent to number of executable lines.

## Table 5.2.2-2
## EP/TOMS Science Processing FORTRAN and C Code Library
(/uv/tprod/ep/src/lib/)

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| convtc.f | convert integer to character string | dskmem (gridt), ktimex.f, ztimex.f | |
| convti.f | convert character string to integer | chkin (gridt), getprm (gridt) | |
| datimx.f | fetch system local time | ktimex.f, whedfo (ozt), ztimex.f | jd |
| day_of_month.c | return day of month corresponding to year and day of year | cdtomsqc.c, gridtcom.c, jd2ymd.c, odsd2o.c, odsorb.c, rufqc.c, v2hdfgen.c, v3hdfgencom.c, wtrufhead (rufgen) | first_jul_day, julian_to_month, leap_year |
| dir_and_base.c | returns path and filename from "path/filename" string | cdtomsqc.c, gridtcom.c, odsmerg.c, playhis.c, v0invent.c, v0p4c.c, v3hdfqc.c | |
| dpchar.f | convert floating point to character | reblk_fmt_i2u.f | ebcasc |
| dpchar_i2u.c | convert IBM double precision to 8 IEEE characters | ephingest.c | |
| dpdp_i2u.c | convert IBM double precision to IEEE double precision | ephingest.c | |
| ebcasc.f | convert EBCDIC to ASCII character | dpchar.f, i2uch.f, reblk_fmt_i2u.f, | |
| findorb.c | returns orbit number for a given date and time | odsorb.c | |
| first_jul_day.c | returns day of year for 1st day of a given month | day_of_month.c, julian_day.c, julian_to_month.c | leap_year |
| get_decade.c | returns decade since s/c launch | | |
| get_yrdoy.c | returns adjusted date | cdtomsqc.c, gridtcom.c, ivprod.c, rufgencom.c, rufqccom.c, oztcom.c, oztqccom.c, v2hdfgencom.c, v3hdfgencom.c | leap_year |
| getgmt.f | get system time in GMT | headot (gridt) | |
| gfsize.f | get file size | acfdump.f, acffill.f | gfsizec |
| gfsizec.c | get file size | gfsize.f | |
| i2ufd.f | convert IBM double precision to UNIX | reblk_fmt_i2u.f | |

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**Table 5.2.2-2** (continued)
**EP/TOMS Science Processing FORTRAN and C Code Library**
(/uv/tprod/ep/src/lib/)

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| i2ufs.f | convert IBM floating point to UNIX | reblk_fmt_i2u.f | |
| iunp1b.f | return byte value as a 4 byte integer | overpass.f, overpass_clst.f, overpass_ten.f, zmtoms.f | |
| iunp2b.f | return 2 byte value as a 4 byte integer | overpass.f, overpass_all, overpass_clst.f, overpass_ten.f | |
| jd.f | return Julian date corresponding to a given calendar date | chkin (gridt), datimx.f, getgha (rufgen) sunxyz (rufgen) | |
| julian_day.c | return Julian day corresponding to a given calendar date | detorb (rufgen), diffdoy.c, eclipse.c, fdfcom.c, findorb.c, odso2d.c, odsmerg.c, odsorb.c, ozto2d.c, rufgencom.c, rufqc.c, rufsub_up.c, ymd2jd.c | first_jul_day, last_day_of_month |
| julian_to_month.c | return month of year of a given Julian date | cdtomsqc.c, day_of_month.c, gridtcom.c, jd2ymd.c, odsd2o.c, odsorb.c, rufqc.c, orbhk (rufgen), v2hdfgen.c, v3hdfgencom.c, -wtrufhead (rufgen) | first_jul_day, leap_year |
| keep_old.c | rename a file prior to over writing | oztcom.c, v0imkorb.c | |
| ktimex.f | convert local system date and time into a character string (YYYY DDD HHMMSS) | | convtc, datimx |
| last_day_of_month.c | return last day of month for given date | julian_day.c | leap_year |
| leap_year.c | returns 1 if given year is a leap year; returns 0 if not | day_of_month.c, diffdoy.c, first_jul_day.c, get_yrdoy.c, gridtcom.c, julian_to_month.c, last_day_of_month.c, snowice (rufgen), v0ingest.c, v0invent.c, v0p4c.c, v0sdump.c, v2hdfgen.c, v2hdfgencom.c | |

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**Table 5.2.2-2** (continued)
**EP/TOMS Science Processing FORTRAN and C Code Library**
(/uv/tprod/ep/src/lib/)

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| leapyr.f | returns .TRUE. if given year is a leap year; returns .FALSE. if not | overpass.f | |
| month_name.c | returns month name as a character string given month of year number | cdtomsqc.c | |
| print_title.c | print title and date stamp on a report | cdtomsqc.c, oztdump.c, ruf_dump.c, rufqc.c, v0idump.c, v0iqc.c, v0sdump.c, v0sqc.c, v0sstrip.c, v0ssubdump.c, v0ssubqc.c | |
| quit.c | graceful exit to UNIX | cdtomsqc.c, diffdoy.c, ephingest.c, ephqccom.c, fdfcom.c, gridtcom.c, ivprod.c, jd2ymd.c, jdstr.c, odsd2o.c, odsmerg.c, odso2d.c, odsorb.c, oztcom.c, oztdump.c, ozto2d.c, oztqccom.c, play2o.c, playhis.c, ruf_dump.c, rufabs_dump.c, rufcal_dump.c, rufgen.c, rufgencom.c, rufhk_dump.c, rufinst_dump.c, rufqc.c, rufqccom.c, rufsub_up.c, v0idump.c, v0imerge.c, v0imkorb.c, v0ingest.c, v0invent.c, v0iqc.c, v0p4c.c, v0sdump.c, v0smerge.c, v0sqc.c, v0sstrip.c, v0ssubdump.c, v0ssubqc.c, v2hdfgencom.c, v2hdfqc.c, v3hdfgencom.c, v3hdfqc.c, ymd2jd.c | |
| rv0s_subdata.c | read spacecraft subset data record | v0ssubdump.c, v0ssubqc.c | |
| rv0s_subhead.c | read spacecraft subset header record | v0ssubdump.c, v0ssubqc.c | |
| unpk2i.f | unpack 2, 2 byte integers from 4 bytes | finday (gridt), fproc (gridt), tproc (gridt) | |
| v0i_cmpdata.c | compare inst. level 0 data records | v0imkorb.c | |
| v0i_cpydata.c | copy instrument level 0 data record | v0imkorb.c | |

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**Table 5.2.2-2** (continued)
**EP/TOMS Science Processing FORTRAN and C Code Library**
(/uv/tprod/ep/src/lib/)

| File Name | Purpose | Called By | Calls To |
|---|---|---|---|
| v0i_rdata.c | read instrument level 0 data record | v0idump.c, v0imkorb.c, v0ingest.c, v0iqc.c, v0i_updhead.c, rufgen | |
| v0i_rhead.c | read instrument level 0 header record | playhis.c, v0idump.c, v0imkorb.c, v0ingest.c, v0iqc.c, v0i_updhead.c, rufgen | |
| v0i_updhead.c | update instrument level 0 header record | v0imkorb.c | |
| v0i_wdata.c | write instrument level 0 data record | v0imkorb.c | |
| v0i_whead.c | write instrument level 0 header record | v0imkorb.c, v0i_updhead.c | |
| v0s_rdata.c | read spacecraft level 0 data record | v0ingest.c, v0sdump.c, v0sqc.c, v0sstrip.c | |
| v0s_rheader.c | read spacecraft level 0 header record | v0ingest.c, v0sdump.c, v0sqc.c, v0sstrip.c | |
| wv0s_subdata.c | write spacecraft subset data record | v0sstrip.c | |
| wv0s_subhead.c | write spacecraft subset header record | v0sstrip.c | |
| ydmd.f | return month and day of month for given year and day of year | updhdr (ozt), whedfo (ozt), headot (gridt) | |
| ztimex.f | convert local system date and time into a character string with day of week, month, day of month, year, hour, minute, and second (DOW MON DD, YYYY HH:MM:SS) | start.f (ozt) | convtc, datimx |

## Table 5.2.2-3
## EP/TOMS Include Library
(*/uv/tprod/ep/src/include/*)

| Name | Purpose | Called By |
|---|---|---|
| CDEBUG.inc | debug flags | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| EDMCCH.inc | QC flags | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| EDMREC.inc | ephemeris data management catalog | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| ENDSUM.inc | end of run summary counters | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| EPHBLK.inc | ephemeris file summary counters | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| EPHTAP.inc | stacked ephemeris tape information | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| ODSFLG.inc | ODS flag | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| ODSREC.inc | ODS data record | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| PRENAM.inc | name of previous ODS | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| TOLERN.inc | tolerances for continuity checks | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| UNTNUM.inc | unit numbers | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| USERIP.inc | user input parameters | /uv/tprod/ep/src/eph/ephqc/ephqc.f |
| a1_db.h | database structures | /uv/tprod/ep/src/v1/rufqc/rufqc.c<br>~~/uv/tprod/ep/src/v2/v2hdfqc/v2hdfqc.c~~<br>/uv/tprod/ep/src/v3/v3hdfqc/v3hdfqc.c |
| a1_db2.h | database structures | /uv/tprod/ep/src/v2/v2hdfqc/v2hdfqc.c |
| ep_db.h | database structures | /uv/tprod/ep/src/v1/rufqc/rufqc.c |
| ep_v0s.h | Spacecraft Level 0 structures | /uv/tprod/ep/src/lib/v0s_rdata.c, v0s_rheader.c<br>/uv/tprod/ep/src/v0/v0ingest/v0ingest.c<br>/uv/tprod/ep/src/v0/v0sdump/v0sdump.c<br>/uv/tprod/ep/src/v0/v0sqc/v0sqc.c<br>/uv/tprod/ep/src/v0/v0sstrip/v0sstrip.c |
| ep_v0ssub.h | Spacecraft Subset structures | /uv/tprod/ep/src/lib/rv0s_subdata.c, wv0s_subdata.c<br>/uv/tprod/ep/src/v0/v0sstrip/v0sstrip.c<br>/uv/tprod/ep/src/v0/v0ssubqc/v0ssubqc.c<br>/uv/tprod/ep/src/v0/v0ssubdump/v0ssubdump.c |

(continued)

**Table 5.2.2-3** (continued)
**EP/TOMS Include Library**
(*/uv/tprod/ep/src/include/*)

| Name | Purpose | Called By |
|---|---|---|
| funlib.h | 1 line functions | /uv/tprod/ep/src/lib/findorb.c<br>/uv/tprod/ep/src/eph/odsmerg/odsmerg.c<br>/uv/tprod/ep/src/v0/v0imkorb/v0imkorb.c<br>/uv/tprod/ep/src/v0/v0ingest/v0ingest.c<br>/uv/tprod/ep/src/v0/voinvent/v0invent.c<br>/uv/tprod/ep/src/v0/v0iqc/v0iqc.c<br>/uv/tprod/ep/src/v0/v0p4c/v0p4c.c<br>/uv/tprod/ep/src/v0/v0sqc/v0sqc.c<br>/uv/tprod/ep/src/v0/v0ssubqc/v0ssubqc.c<br>/uv/tprod/ep/src/v1/ruf_dump/ruf_dump.c<br>/uv/tprod/ep/src/v1/rufabs_dump/rufabs_dump.c<br>/uv/tprod/ep/src/v1/rufcal_dump/rufcal_dump.c<br>/uv/tprod/ep/src/v1/rufhk_dump/rufhk_dump.c<br>/uv/tprod/ep/src/v1/rufinst_dump/rufinst_dump.c<br>/uv/tprod/ep/src/v1/rufgen/addtim.c, approx.c, cross.c, detatt.c, deteph.c, detorb.c, dofov.c, dotang.c, elocat.c, geodet.c, getgha.c, locate.c, orbhk.c, radecm.c, readcov.c, rufgen.c, scaninfo.c, sccaen.c, snowice.c, subsat.c, sunxyz.c, terrain.c, vertic.c<br>/uv/tprod/ep/src/v1/rufgencom/rufgencom.c<br>/uv/tprod/ep/src/v1/rufqc/rufqc.c<br>/uv/tprod/ep/src/v1/rufsub_up/binsort.c, rufsub_up.c<br>/uv/tprod/ep/src/v2/ozto2d/ozto2d.c |
| general.h | constants | /uv/tprod/ep/src/lib/findorb.c<br>/uv/tprod/ep/src/eph/odsmerg/odsmerg.c<br>/uv/tprod/ep/src/v0/playhis/playhis.c<br>/uv/tprod/ep/src/v0/v0imkorb/v0imkorb.c<br>/uv/tprod/ep/src/v0/v0ingest/v0ingest.c |

(continued)

**Table 5.2.2-3** (continued)
**EP/TOMS Include Library**
(*/uv/tprod/ep/src/include/*)

| Name | Purpose | Called By |
|---|---|---|
| general.h (continued) | constants | /uv/tprod/ep/src/v0/v0invent/v0invent.c<br>/uv/tprod/ep/src/v0/v0iqc/v0iqc.c<br>/uv/tprod/ep/src/v0/v0s/v0sqc/v0sqc.c<br>/uv/tprod/ep/src/v0/v0ssubqc/v0ssubqc.c<br>/uv/tprod/ep/src/v1/ruf_dump/ruf_dump.c<br>/uv/tprod/ep/src/v1/rufabs_dump/rufabs_dump.c<br>/uv/tprod/ep/src/v1/rufcal_dump/rufcal_dump.c<br>/uv/tprod/ep/src/v1/rufhk_dump/rufhk_dump.c<br>/uv/tprod/ep/src/v1/rufinst_dump/rufinst_dump.c<br>/uv/tprod/ep/src/v1/rufgen/addtim.c, approx.c, cross.c, detatt.c, deteph.c, detorb.c, dofov.c, dotang.c, elocat.c, geodet.c, getgha.c, locate.c, orbhk.c, radecm.c, readcov.c, rufgen.c, scaninfo.c, sccaen.c, snowice.c, subsat.c, sunxyz.c, terrain.c, vertic.c<br>/uv/tprod/ep/src/v1/rufqc/rufqc.c<br>/uv/tprod/ep/src/v1/rufsub_up/binsort.c, rufsub_up.c, select_cal.c<br>/uv/tprod/ep/src/v2/oztdump/oztdump.c<br>/uv/tprod/ep/src/v2/ozto2d/ozto2d.c |
| ozt.h | Level 2 structures | /uv/tprod/ep/src/v2/oztdump/oztdump.c<br>/uv/tprod/ep/src/v2/ozto2d/ozto2d.c |
| oztdat.h | Level 2 scene structure | /uv/tprod/ep/src/v2/oztqc/oztqc.c, readozrec.c |
| protypes.h | time function prototypes | /uv/tprod/ep/src/lib/day_of_month.c, first_jul_day.c, get_yrdoy.c, julian_day.c, julian_to_month.c, last_day_of_month.c, month_name.c<br>/uv/tprod/ep/src/eph/ephqccom/ephqccom.c<br>/uv/tprod/ep/src/v3/gridtcom/gridtcom.c |

(continued)

**Table 5.2.2-3** (continued)
**EP/TOMS Include Library**
(*/uv/tprod/ep/src/include/*)

| Name | Purpose | Called By |
|---|---|---|
| protypes.h | time function prototypes | /uv/tprod/ep/src/lib/day_of_month.c, first_jul_day.c, get_yrdoy.c, julian_day.c, julian_to_month.c, last_day_of_month.c, month_name.c<br>/uv/tprod/ep/src/eph/ephqccom/ephqccom.c<br>/uv/tprod/ep/src/v3/gridtcom/gridtcom.c |
| ruf.h | Level 1 structures | /uv/tprod/ep/src/v1/ruf_dump/ruf_dump.c<br>/uv/tprod/ep/src/v1/rufabs_dump/rufabs_dump.c<br>/uv/tprod/ep/src/v1/rufcal_dump/rufcal_dump.c<br>/uv/tprod/ep/src/v1/rufhk_dump/rufhk_dump.c<br>/uv/tprod/ep/src/v1/rufinst_dump/rufinst_dump.c<br>/uv/tprod/ep/src/v1/rufgen/detorb.c, dofov.c, elocat.c, fillelo.c, orbhk.c, rufgen.c, scaninfo.c, sccaen.c, subsat.c, wtlastrec.c, wtrufdata.c, wtrufhead.c<br>/uv/tprod/ep/src/v1/rufqc/rufqc.c<br>/uv/tprod/ep/src/v1/rufsub_up/rufsub_up.c, select_cal.c |
| v0i.h | Instrument Level 0 structures | /uv/tprod/ep/src/lib/v0icmpdata.c, v0icpydata.c, v0i_rdata.c, v0i_rhead.c, v0i_updhead.c, v0i_wdata.c, v0i_whead.c<br>/uv/tprod/ep/src/v0/playhis/playhis.c<br>/uv/tprod/ep/src/v0/v0imkorb/v0imkorb.c<br>/uv/tprod/ep/src/v0/v0ingets/v0ingest.c<br>/uv/tprod/ep/src/v0/v0iqc/v0iqc.c<br>/uv/tprod/ep/src/v0/v0idump/v0idump.c<br>/uv/tprod/ep/src/v1/rufgen/detorb.c, dofov.c, elocat.c, orbhk.c, rufgen.c, scaninfo.c, wtrufhead.c |

## Table 5.2.2-4
## EP/TOMS Utility Program Library
(*/uv/tprod/ep/src/util/*)

| Name | Purpose | Inputs | Outputs | Called By | Calls To |
|---|---|---|---|---|---|
| diffdoy | print difference between dates | YYYY, MM, & DD @ T1 & T2 | difference (days) | /uv/tprod/ep/bin/ephingest | julian_day<br>leap_year |
| jd2ymd | print year, month of year, & day of month for given day of year | YYYY & DDD | YYMMDD | cdclim.bat, cdorimag.bat, ephingest, fulldaymap.bat, leve0i1main, ~~overpass_all, overpass_clst,~~ polmap.bat, real_image | julian_to_month<br>day_of_month |
| jdstr | convert integral number to an n-character string (incl leading zeroes) | integral number & number of bytes to convert | string | /uv/tprod/ep/bin/arch_main, cdorimag, cdtomsqc, v0ssub, eclipse, eph_dump, gridt, ivprod_bat, ivprod_main, lev0i1, noaa_volcano2, ~~overpass, overpass_all, overpass_clst,~~ ozt, ozt_dump, ozto2d, ozto2dmain, oztqc, oztrun, reali_ep, realimain, ruf_dump, rufgen, rufqc, rufsub_up, v0idump, v0iqc, v0sqc, v2hdfgen.sh, v2hdfqc.sh, v3hdfqc.pl, zmtoms, zmtoms_main | |
| odsd2o | print orbit number range for a given date | YYYY, MM, DD | orbit range | /uv/tprod/ep/bin/ivprod_bat | yr_to_year<br>get_maxdoy<br>julian_to_month<br>day_of_month<br>findorb |

(continued)

**Table 5.2.2-4** (continued)
**EP/TOMS Utility Program Library**
(*/uv/tprod/ep/src/util/*)

| Name | Purpose | Inputs | Outputs | Called By | Calls To |
|---|---|---|---|---|---|
| odso2d | print date & time of given orbit number(s) | orbit(s) | start date & time | /uv/tprod/ep/bin/reali_ep | yr_to_year<br>julian_day |
| odsorb | print orbit number for a given date & time | YYYY MM DD HHMMSS (opt. c) or YYYY DDD SSSSS (opt j) | orbit number | | julian_day<br>julian_to_month<br>day_of_month<br>findorb |
| scanorb | verify number of scans to Orbital Counts File | Orbital Counts filename, orbit number, & expected number of scans | return code=0 if confirmed; else 1 | /uv/tprod/ep/bin/v2hdfqc.sh | |
| ymd2jd | print year & day of year for given calendar date | YY or YYYY, MM, & DD | YYYY DDD | /uv/tprod/ep/bin/cdorimag, ephingest, lev0i1 | julian_day |

## 5.3 Process Control

EP/TOMS science processing software is executed either automatically or manually.

The following EP/TOMS Science Operation Center data processing functions are performed through automatic software execution:

- QC checks on all incoming science data and spacecraft ephemeris
- near real-time science data processing
- distribution of near real-time science products
- calibration product generation
- validation product generation
- data and system backup

Automatic execution of the software components required to perform these functions is triggered by cron jobs that watch for the presence of new data files in designated delivery areas.

Manual execution is necessary for the following EP/TOMS science operation functions:

- auxiliary file generation/update
- product redo, reprocessing, or special processing
- data display
- support software access

Manual execution of most components is provided through an interactive operator interface. This operator interface controls access to production executables, ensures correct processing configuration, and facilitates job set-up and scheduling.

### 5.3.1 Automatic Software Execution

Automatic software execution within the EP/TOMS Science Data Processing System is controlled through the UNIX *cron* facility. At the time of this writing there are 10 *crontab* entries that are related to EP/TOMS science data processing. These entries are listed in Table 5.3.1-1. Each *cron* triggers the execution of a UNIX command or a UNIX shell or Perl script. ~~Execution of UNIX shell scripts typically lead~~Execution of UNIX shell scripts typically leads to the execution of a FORTRAN, C, or IDL program.

*cron* 1: check for new Level 0 files and, if found, initiate near real-time processing

Figure 5.3.1-1 shows the executions that are triggered by *cron* 1. The *v0ingest* script looks in the Level 0 delivery directory (i.e. */home/tmocf*) for files to process. No specific filename is assumed; the presence of any files in this directory triggers further processing. If files are found the process "sleeps" for 10 seconds to ensure that a complete file transfer has occurred. Then the process shown in Figure 5.3.1-1 continues.

If the file is a Spacecraft Level 0 file a quality check is performed, the file is logged, and a subsetting process is initiated. This subsetting is delayed 500 seconds to allow time for completion of the processing of the Instrument Level 0 file from the same playback.

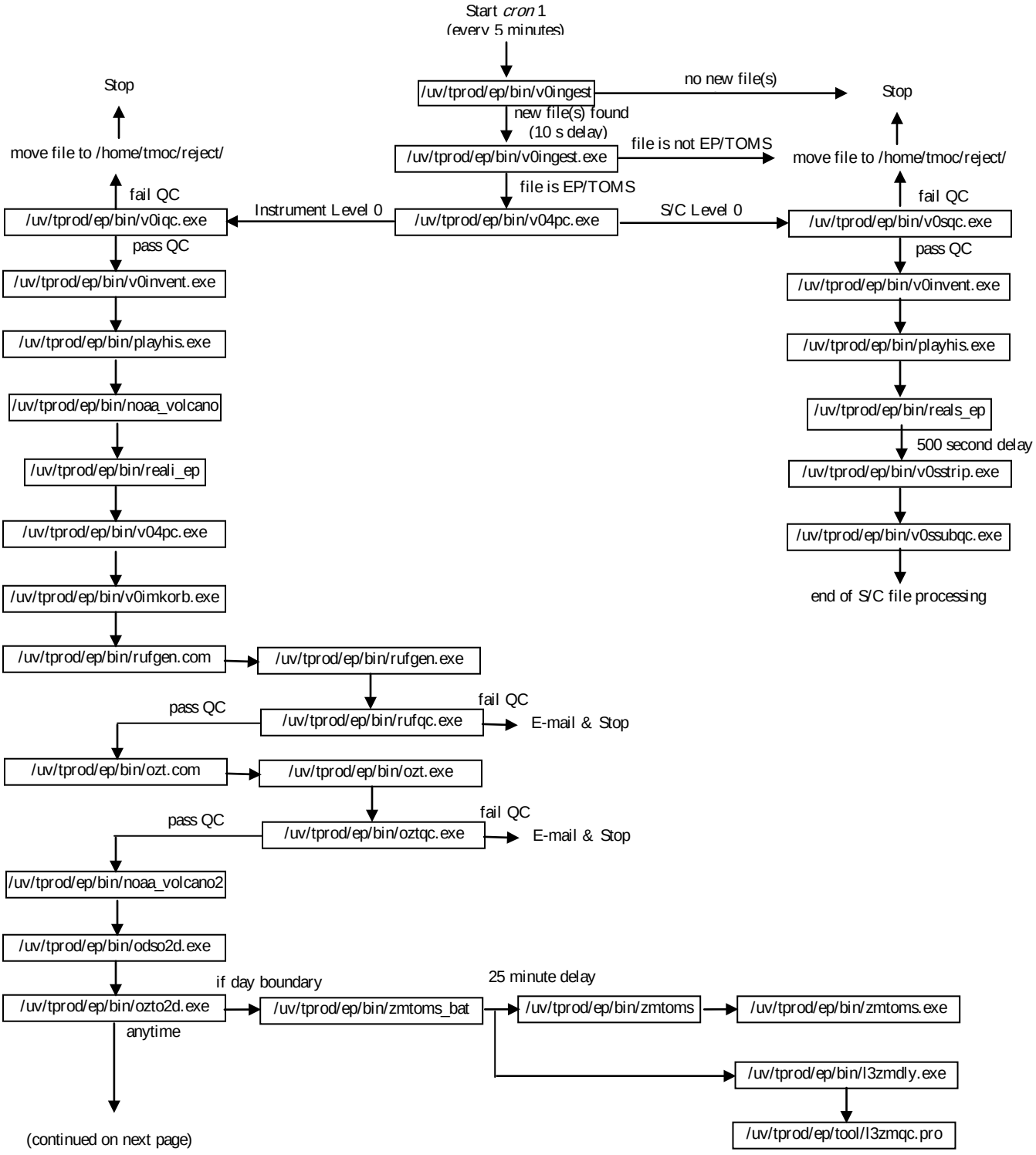
If the file is an Instrument Level 0 file a quality check is performed, the file is logged and copied to NOAA accessible directories, and then is processed to near real-time science products. The

## Table 5.3.1-1

## EP/TOMS '*cron*' Initiated Processes

| cron | Function | Call To: | Schedule |
|---|---|---|---|
| 1 | check for new Level 0 files and, if found, initiate near real-time processing of those files | /uv/tprod/ep/bin/v0ingest | every 15 minutes |
| 2 | check for new Spacecraft Ephemeris files and, if found, initiate near real-time processing of those files | /uv/tprod/ep/bin/ephingest | every 10 minutes |
| 3 | backup new Instrument Level 0 files | /uv/tprod/ep/bin/backup_vz_bat | daily at 03:15 (local) |
| 4 | backup new Spacecraft Subset files | /uv/tprod/ep/bin/backup_vz_bat | daily at 03:30 (local) |
| 5 | backup new Spacecraft Ephemeris files | /uv/tprod/ep/bin/backup_eph_bat | Saturday at 02:15 (local) |
| 6 | perform calibration processing | /uv/tprod/ep/bin/ivprod_bat | Wednesday at 1560:300 (local) |
| 7 | backup processing system to "wrabbit" | /home/tomsprod/bin/mirror.pl | daily at 05:00 & 15:00 (local) |
| 8 | update monthly set of daily total ozone images | /home/tomsprod/bin/monthlymap.pl | daily at 04:00 (local) |
| 9 | generate Monthly Level 3 Zonal Means files | /uv/tprod/ep/bin/l3zmmly | 2nd day of every month @ 6:00 (local) |
| 10 | generate Level 3 Monthly Averages files | /uv/tprod/ep/bin/monav | 2nd day of every month @ 7:00 (local) |

# Figure 5.3.1-1
# EP/TOMS Automatic Software Execution
## *cron* 1: check for new Level 0 files and, if found, initiate near real-time processing of those files

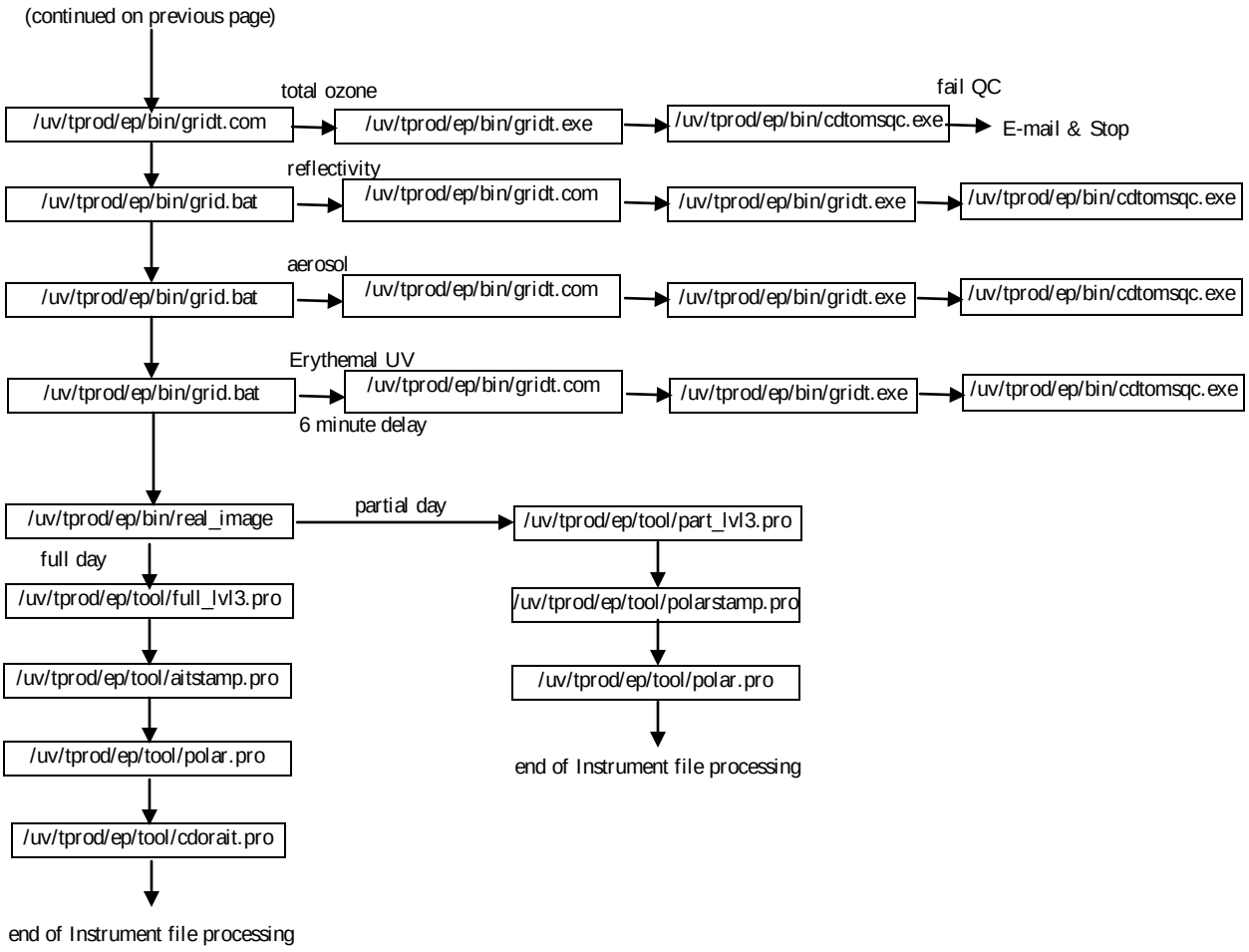



NOTE: this figure shows execution sequence;
process control relationships may differ

**Figure 5.3.1-1** (continued from previous page)

## EP/TOMS Automatic Software Execution

***cron* 1: check for new Level 0 files and, if found, initiate near real-time processing of those files**




NOTE: this figure shows execution sequence; process control relationships may differ

processing starts by building orbital Instrument Level 0 files. Each of these orbital files is then processed to Level 1, 2, and 3 data products. An independent file QC is performed on each product immediately following file generation. Updates to ~~Overpass and~~ Zonal Means Filedatasets are triggered whenever a day boundary is crossed. ~~Overpass and Zonal Means processing is performed on a delayed basis so as not to interfere with near real-time Level 3 processing.~~

Near real-time processing ends following conclusion of Level 3 image generation and distribution.

### *cron* 2: check for new Spacecraft Ephemeris files and, if found, initiate near real-time processing of those files

Figure 5.3.1-2 shows the executions that are triggered by *cron* 2. The *ephingest* script looks in the Spacecraft Ephemeris delivery directory (i.e. */home/fdf/*) for files to process. The presence of any files in this directory triggers further processing. Filenames that start with 'p' are predictive ephemeris; filenames that start with 'd' are definitive. Processing continues if the file is for EP/TOMS. This processing consists of a reformatting from IBM format to UNIX format, quality checks on data format and consistency, and the building of an orbit table.

Processing of predictive ephemeris files ends after copies are made available to NOAA NESDIS. Definitive ephemeris processing ends after the definitive Master Orbit Table is updated.

### *cron* 3: backup new Instrument Level 0 files

Figure 5.3.1-3 shows the executions that are triggered by *cron* 3. The *backup_vz_bat* script determines the dates of the previous 2 days and passes this information to the *backup_vz* script. The *backup_vz* script locates all Instrument Level 0 files received in the previous 2 days and copies these files (using UNIX '*tar*') to a designated disk on the '*mhatter*' workstation (presently */misc/mhdat22/ep/arch/v0i/*).

### *cron* 4: backup new Spacecraft Subset files

Figure 5.3.1-3 also shows the executions that are triggered by *cron* 4. The *backup_vz_bat* script determines the dates of the previous 2 days and passes this information to the *backup_vz* script. The *backup_vz* script locates all Spacecraft Subset files produced from Spacecraft Level 0 files received in the previous 2 days and copies these files (using UNIX '*tar*') to a designated disk on the '*mhatter*' workstation (presently */misc/mhdat22/ep/arch/v0ss/*).

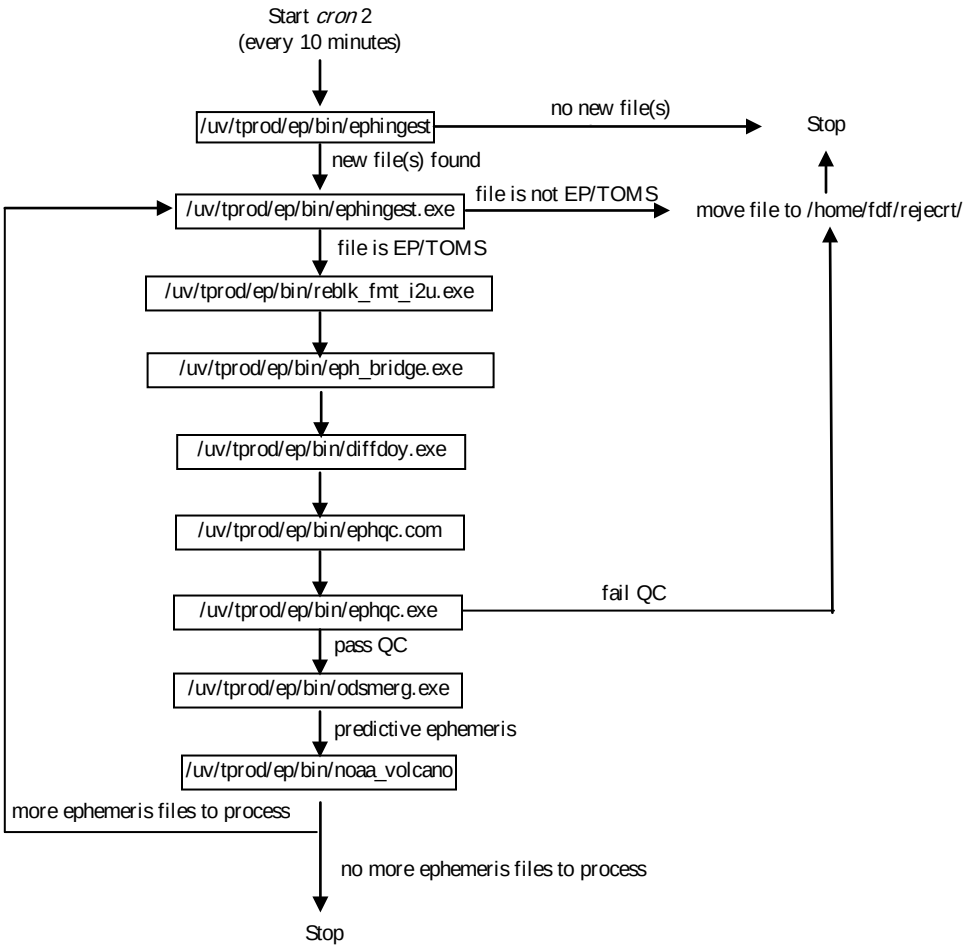
### *cron* 5: backup new Spacecraft Ephemeris files

Figure 5.3.1-3 also shows the executions that are triggered by *cron* 5. The *backup_eph_bat* script determines the dates of the previous 2 weeks and passes this information to the *backup_eph* script. The *backup_eph* script locates all definitive Spacecraft Ephemeris files received in the previous 2 weeks and copies these files (using UNIX '*cp*') to a designated disk on the '*mhatter*' workstation (presently */misc/mhdat22/ep/arch/eph/*).

### *cron* 6: perform calibration processing

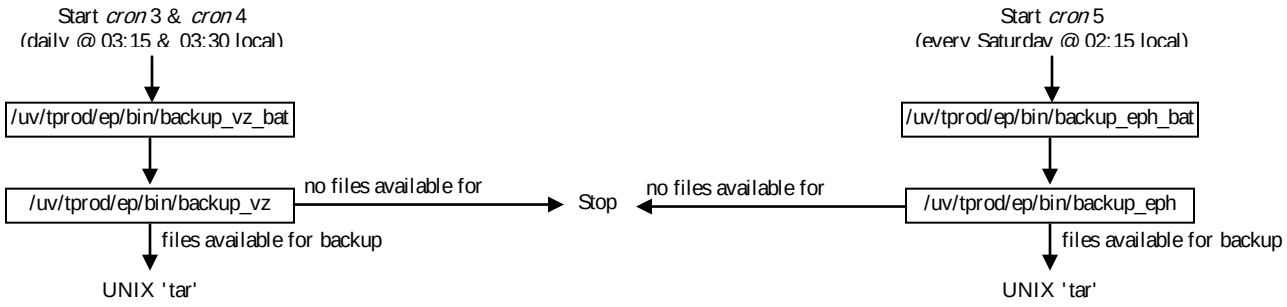
Figure 5.3.1-4 shows the executions that are triggered by *cron* 6. The *ivprod_bat* script triggers a series of scripts and FORTRAN executables that produce Calibration Products and update the Albedo Correction File. As shown in Figure 5.3.1-4, if there are no Level 1 files for the week then an e-mail notification is sent to the operator and the process stops.

# Figure 5.3.1-2
# EP/TOMS Automatic Software Execution
## *cron* 2: check for new Spacecraft Ephemeris files and, if found, initiate near real-time processing of those files

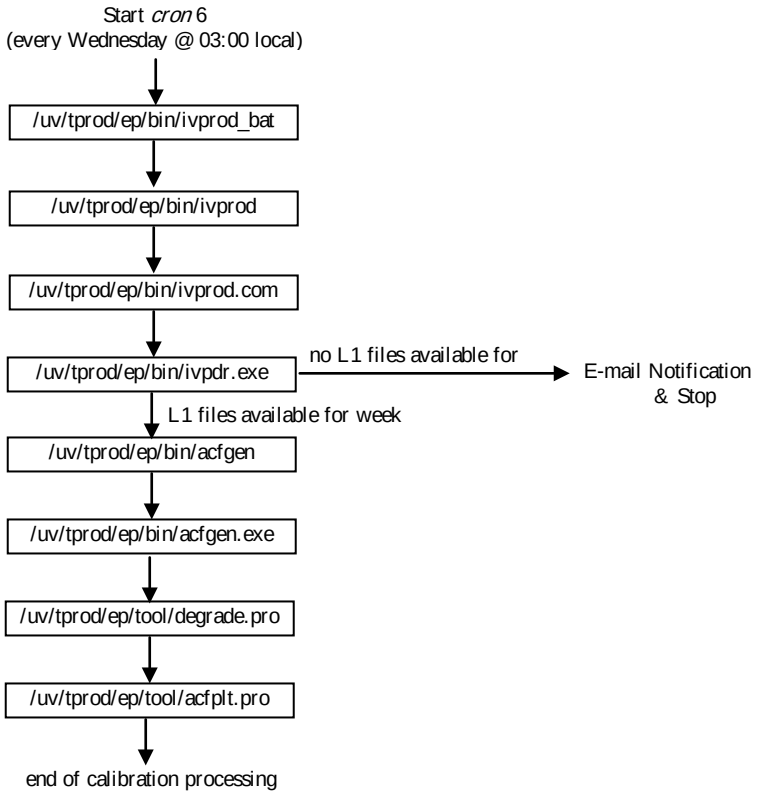



NOTE: this figure shows execution sequence; see Figure 5.1.1-1 for the data flow through the Ephemeris Processing Subsystem.

# Figure 5.3.1-3
# EP/TOMS Automatic Software Execution
## *cron* 3: backup new Instrument Level 0 files
## *cron* 4: backup new Spacecraft Subset files
## *cron* 5: backup new Spacecraft Ephemeris files



# Figure 5.3.1-4
# EP/TOMS Automatic Software Execution
## *cron* 6: perform calibration processing



*cron* 7: backup processing system to "*wrabbit*"

Figure 5.3.1-5 shows the executions that are triggered by *cron* 7. The *mirror.pl* script uses the UNIX *'tar'* command to copy the processing system to the backup (presently *'wrabbit'*) workstation.

*cron* 8: update monthly set of daily total ozone images

Figure 5.3.1-5 also shows the executions that are triggered by *cron* 8. The *monthlymap.pl* script prepares a monthly set of daily Level 3 total ozone images using the IDL program in */uv/tprod/ep/tool/cdormon.pro*.

*cron* 9: generate monthly level 3 zonal means

Figure 5.3.1-5 also shows the executions that are triggered by *cron* 9. The */l3zmmly* script generates monthly level 3 zonal means files for the previous month.

*cron* 10: generate level 3 monthly averages

Figure 5.3.1-5 also shows the executions that are triggered by *cron* 10. The *monav* script generates level 3 monthly averages files for the previous month.

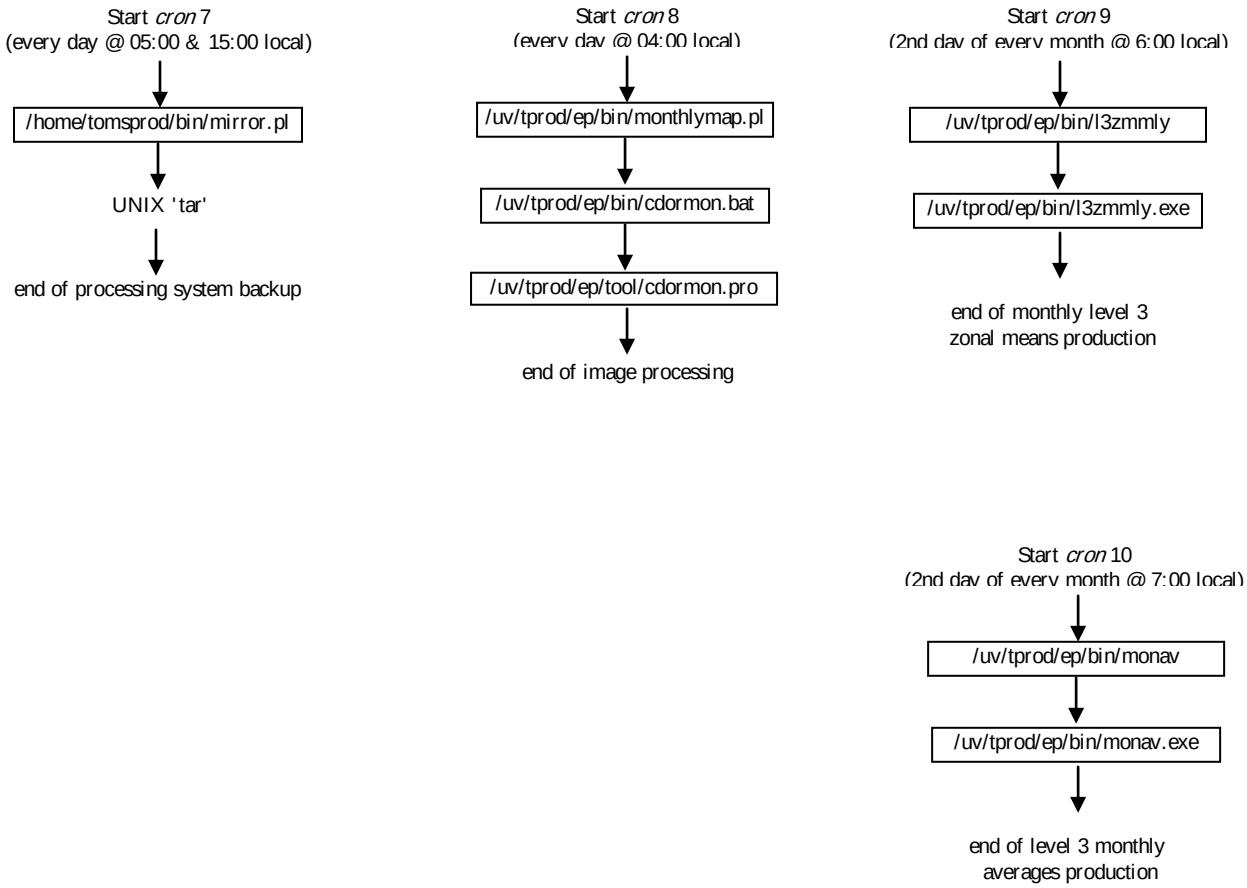
### 5.3.2 Manual Software Execution

Operator interactions with the EP/TOMS Science Data Processing System are through an interactive menu interface. This character based menu interface is a hierarchy of scripts that typically leads to the execution of FORTRAN, C, or IDL executables. These scripts are written in either UNIX shell or Perl. User prompts are issued throughout to select options and to enter process control parameters. Whenever the operator is presented with a selection menu an "x. Exit" option is provided. All menus (except for the Main Menu) have a "r. Return ..." selection to return to the previous menu. The hierarchy of menus is shown in Figure 5.3.2-1.

This menu interface may be entered by executing either */uv/tprod/ep/bin/toms* or */uv/tprod/ep/bin/ep*. The former allows the operator to select either the TOMS Science Data Processing System or the TOMS Image Processing System (see Figure 5.3.2-2). If entering the TOMS Science Data Processing System through */uv/tprod/ep/bin/toms* the operator is given the option of Nimbus-7/TOMS, Meteor-3/TOMS, Earth Probe/TOMS, or ADEOS/TOMS. The alternate */uv/tprod/ep/bin/ep* entry point places the operator directly in the EP/TOMS Science Data Processing System (see Figure 5.3.2-3).

Figure 5.3.2-2 illustrates the TOMS Science Data Processing System's Main Menu and the paths followed in the TOMS Image Processing System. In this diagram (and others in this section) menu prompts are shown within boxes with the menu name at the top. Selections are shown exactly as they appear on the operator's screen. Arrows show the execution path that results from each selection.

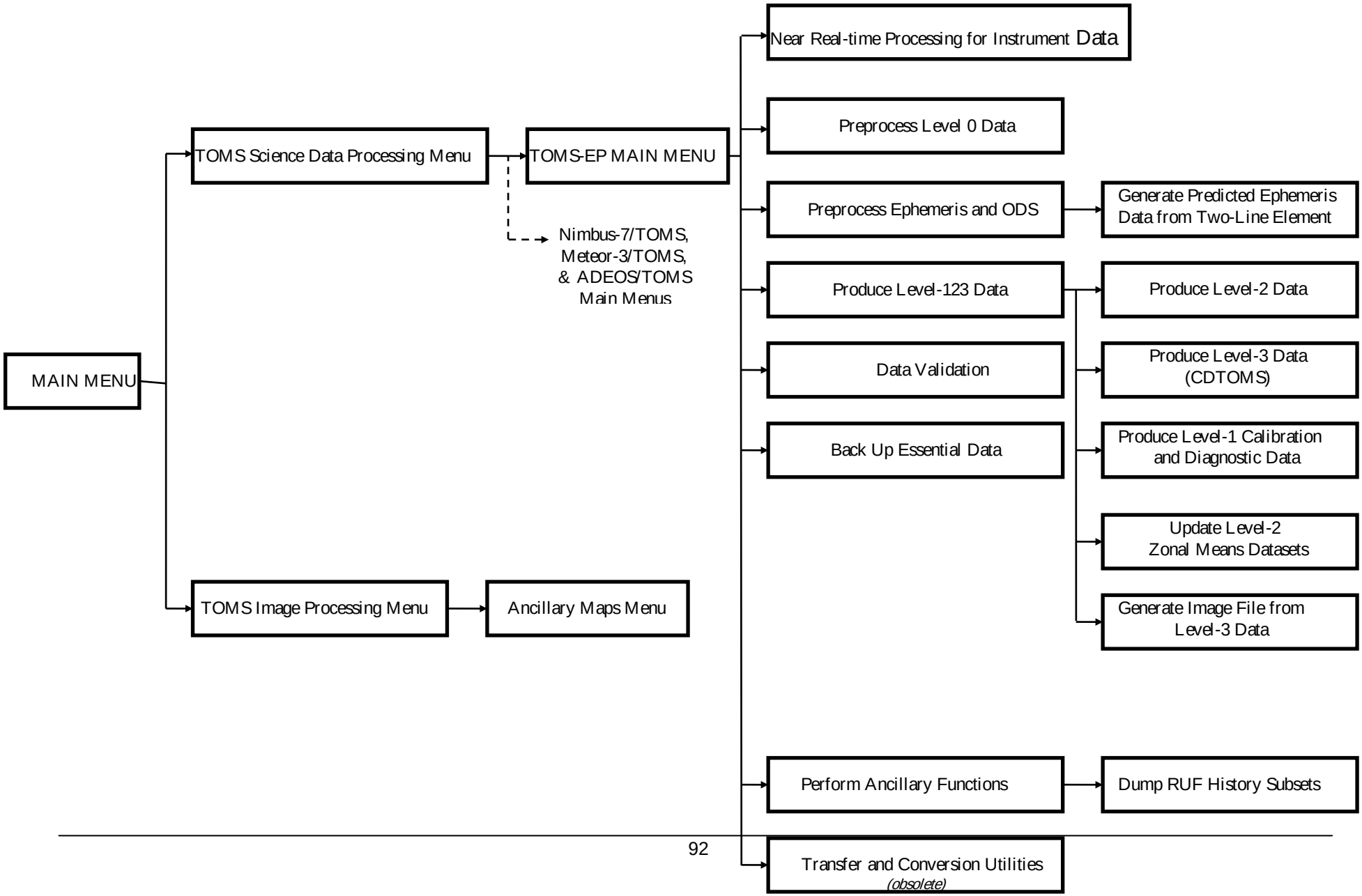
# Figure 5.3.1-5
# EP/TOMS Automatic Software Execution
## *cron* 7: backup processing system to 'wrabbit'
## *cron* 8: update monthly set of daily total ozone images
## *cron* 9: generate monthly level 3 zonal means
## *cron* 10: generate level 3 monthly averages



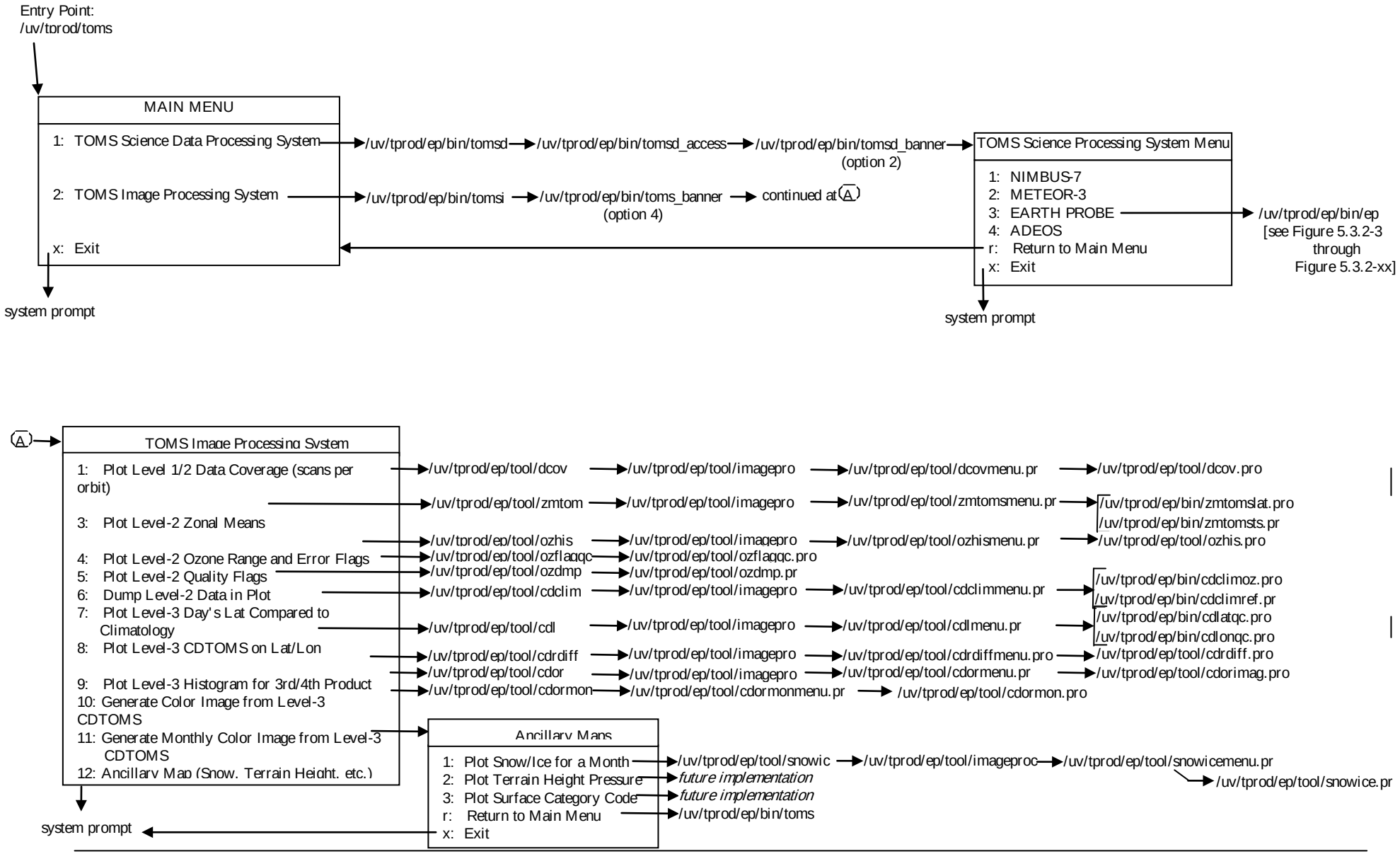

NOTE: this figure shows execution sequence; see Figures 5.1.8-1 and 5.1.9-1 for the data flow through the Zonal Means and Level 3 Processing Subsystems.

NOTE: this figure shows execution sequence; process control relationships may differ

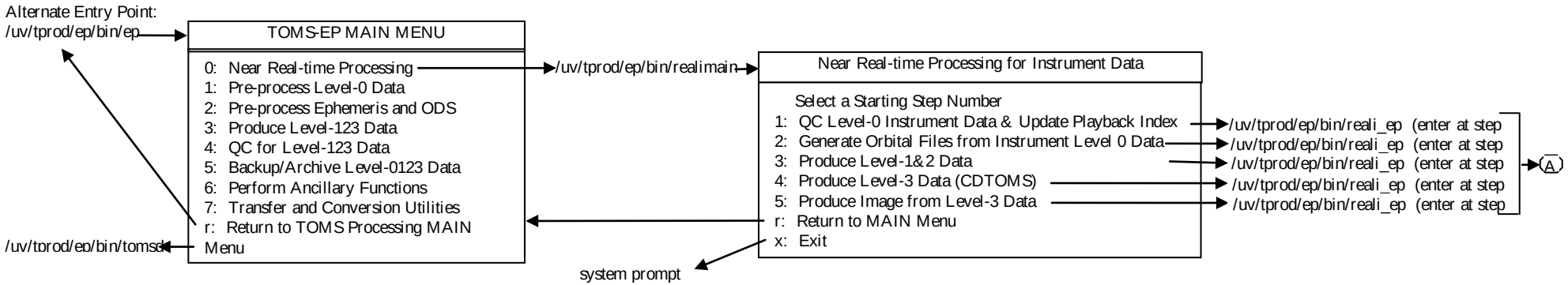
**Figure 5.3.2-1**
**Operator Menu Hierarchy Diagram**

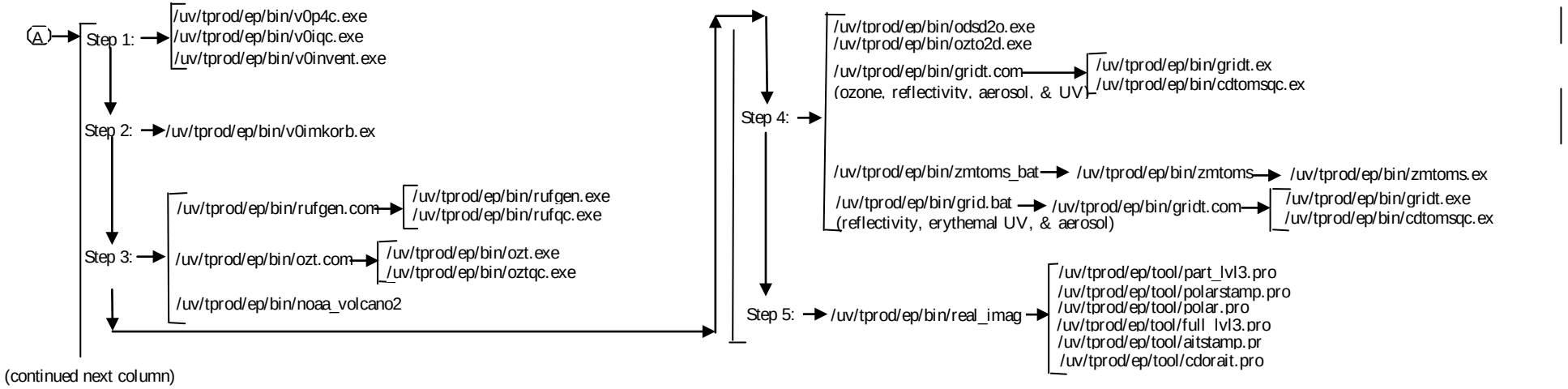


## Figure 5.3.2-2
## EP/TOMS Science Data Processing Operator Interface



# Figure 5.3.2-3
# EP/TOMS Science Data Processing Operator Interface
# Near Real-time Processing



As shown in Figure 5.3.2-2 entry into the TOMS Image Processing System provides operator selections for:

1. Plot Level 1/2 Data Coverage (scans per orbit)
3. Plot Level-2 Zonal Means
4. Plot Level-2 Ozone Range and Error Flags
5. Plot Level-2 Quality Flags
6. Dump Level-2 Data in Plot
7. Plot Level-3 Day's Lat Compared to Climatology
8. Plot Level-3 CDTOMS on Lat/Lon
9. Plot Level-3 Histogram for 3rd/4th Product
10. Generate Color Image from Level-3 Data
11. Generate Monthly Color Image from Level-3 CDTOMS
12. Ancillary Map (Snow, Terrain Height, etc.)

Selections in the TOMS Image Processing System lead to the execution of the IDL program(s) that produce the desired image. Image generation program execution is set up and controlled via UNIX scripts or other IDL programs as shown in Figure 5.3.2-2. Interactive prompts, in the form of IDL widgets, are presented to the operator throughout this system.

The Ancillary Maps menu is the only sub-menu entered from the TOMS Image Processing System menu. This sub-menu allows the operator to select from the following:

1. Plot Snow/Ice for a Month
2. Plot Terrain Height Pressure
3. Plot Surface Category Code

As shown in Figure 5.3.2-3 the sub-menus available for EP/TOMS science data processing are:

0. Near Realtime Processing
1. Pre-process Level-0 Data
2. Pre-process Ephemeris and ODS
3. Produce Level-123 Data
4. QC Level-123 Data
5. Backup/Archive Level-0123 Data
6. Perform Ancillary Functions
7. Transfer and Conversion Utilities

## Near Real-time Processing

The "Near Real-time Processing" selection allows the operator to select a starting point in the near real-time processing pipeline. This is useful whenever a restart is required (automated near real-time processing failure) or a product redo is needed (software modification or lost/corrupted data file).

The "Near Real-time Processing" selection causes the Near Real-time Processing for Instrument Data Menu to be displayed. This menu has selections for:

1. QC Level-0 Instrument Data & Update Playback Index
2. Generate Orbital Files from Instrument level-0 Data
3. Produce Level-1&2 Data

4. Produce Level-3 Data (CDTOMS)
5. Produce Image from Level-3 Data

Any of these selections will result in the execution of the */uv/tprod/ep/bin/reali_ep* script. The *reali_ep* script has several entry points that start processing at different steps. The FORTRAN, C, IDL, and shell executables invoked at each step is shown in Figure 5.3.2-3.

Descriptions of the *v0p4c.exe, v0iqc.exe, v0invent.exe, v0imkorb.exe, rufgen.com, rufgen.exe, rufqc.exe, ozt.com, ozt.exe, oztqc.exe, odsd2o.exe, ozto2d.exe, gridt.com, gridt.exe, cdtomsqc.exe,* and *zmtoms.exe* programs are in Sections 5.1 and 5.2 and Appendices F, H, J, L, and M.

## Pre-process Level-0 Data

The "Pre-process Level-0 Data" selection causes the Pre-process Level-0 Data Menu to be displayed. This menu has selections to:

1. Ingest Level-0 Source Data & Update Playback Index
2. QC Instrument Level-0 Data
3. Split/Merge Instrument Level-0 Data into Orbital Files
4. QC Spacecraft Level-0 Data
5. Strip Spacecraft Data into a Subset

The C and shell executables invoked as the result of each selection are shown in Figure 5.3.2-4.

Descriptions of the *v0ingest.exe, v0p4c.exe, v0iqc.exe, v0sqc.exe, v0invent.exe, playhis.exe, v0sstrip.exe,* and *v0ssubqc.exe* programs are in Sections 5.1 and 5.2 and Appendix F.

## Pre-process Ephemeris Data and ODS

The "Pre-process Ephemeris Data and ODS" selection causes the Pre-process Ephemeris Data and ODS Menu to be displayed. This menu has selections to:

1. Generate Predictive Ephemeris Data from Two-Line Element
2. Ingest Definitive Ephemeris Data
3. QC and Generate Ephemeris Data and ODS
4. Dump Ephemeris Data
5. Update Master ODS

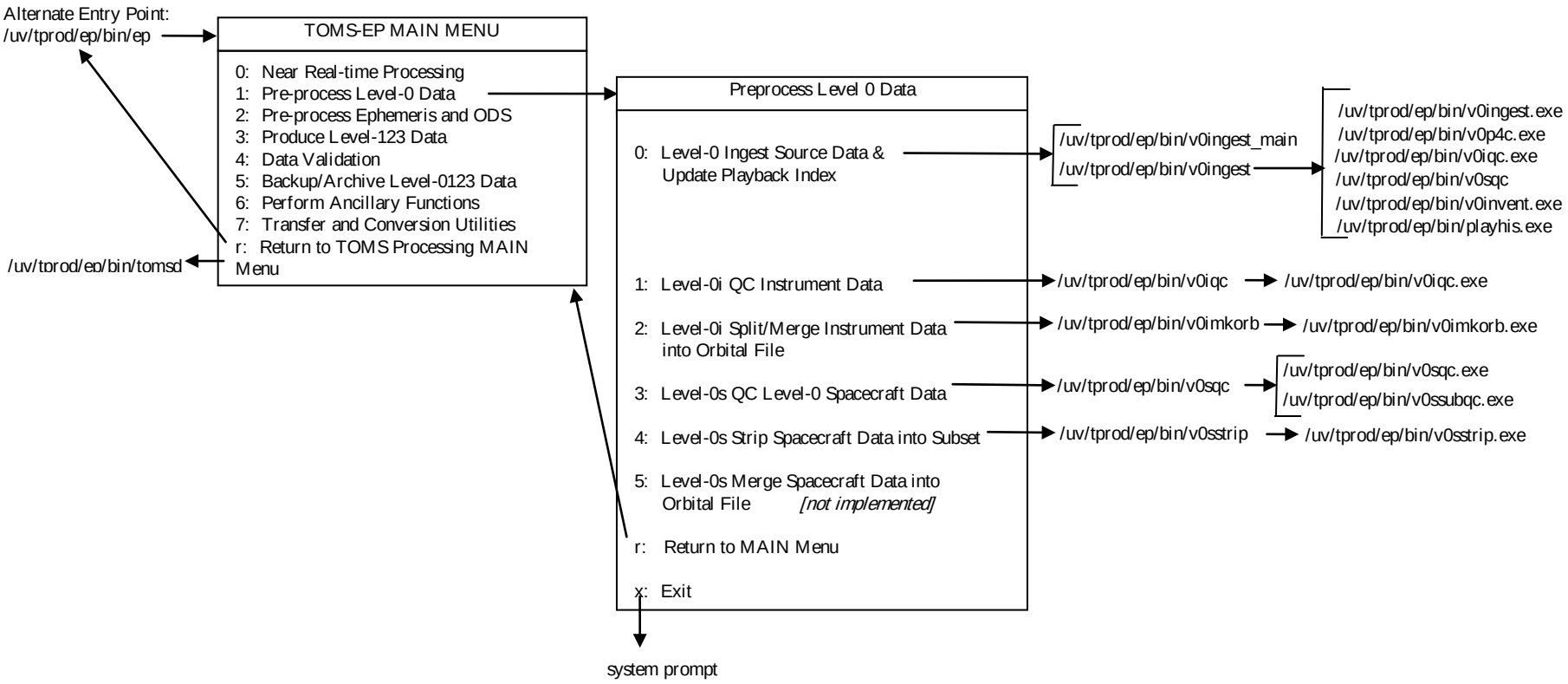
The Generate Predicted Ephemeris Data from Two-Line Element Menu allows the operator to step through the following process:

1. Get Two-Line Element from NORAD
2. Download tle and Get ASCII Orbital Data
3. Convert ASCII Orbital Data to FDF Format
4. QC to Generate New Ephemeris and ODS

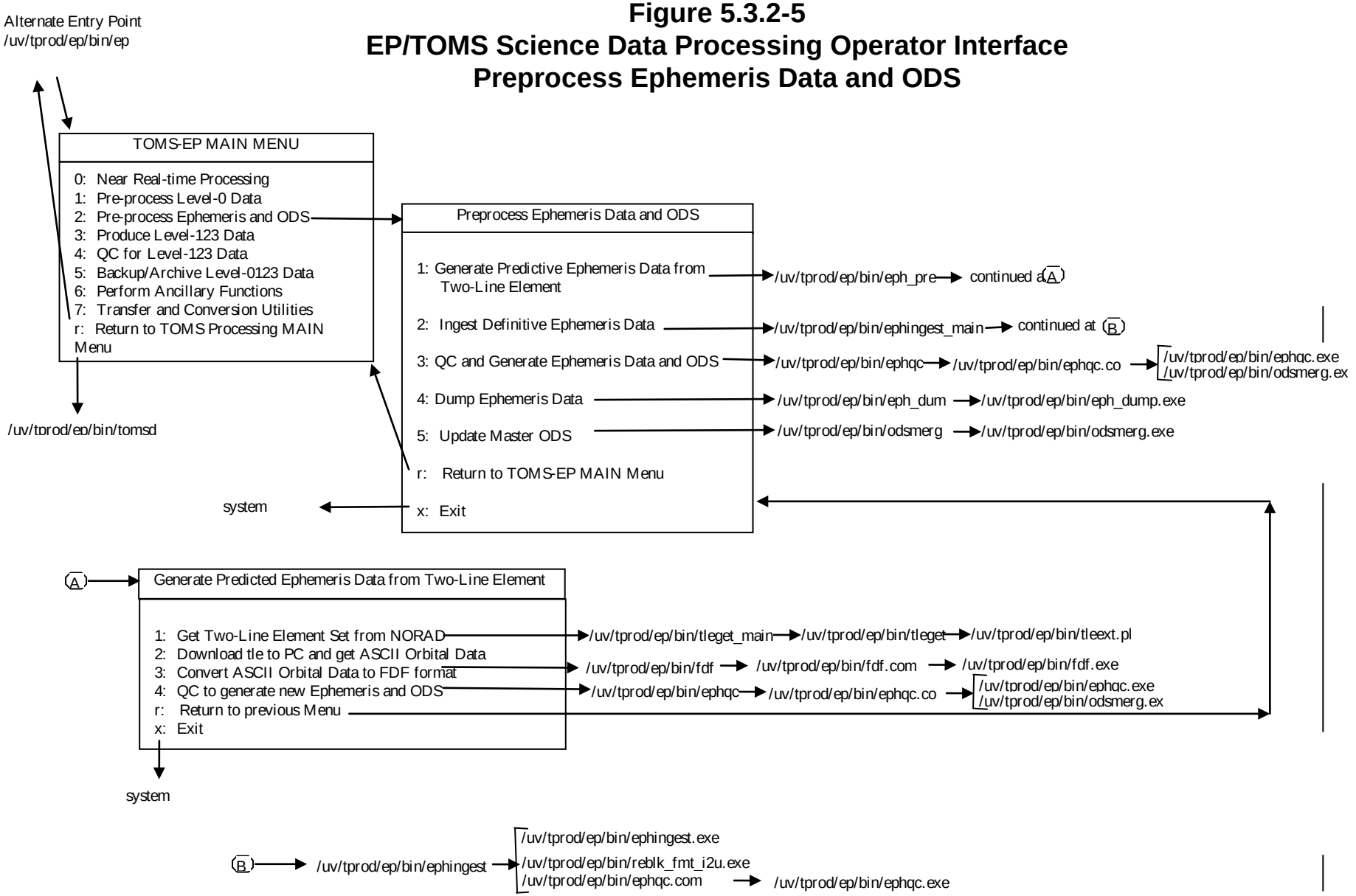
The FORTRAN, C, and shell executables invoked as the result of each selection are shown in Figure 5.3.2-5.

Descriptions of the *ephqc.com, ephqc.exe, odsmerg.exe,* and *eph_dump.exe* programs are in Sections 5.1.1 and Appendix E.

## Figure 5.3.2-4
## EP/TOMS Science Data Processing Menu Driven Operator Interface
## Preprocess Level-0 Data



## Figure 5.3.2-5
## EP/TOMS Science Data Processing Operator Interface
## Preprocess Ephemeris Data and ODS



## Produce Level-123 Data

The "Produce Level-123 Data" selection causes the Produce Level-123 Data Menu to be displayed. This menu has selections to:

1. Produce Level-0 and Level-1 Data
2. Produce Level-1 Data
3. Produce Level-2 Data
4. Update Level-1 Subsets
5. Produce Level-1 Calibration and Diagnostic Data
6. Update Zonal Means Dataset
7. Produce Level-2 HDF Data
8. Produce Level-3 HDF Data

Each selection except "Produce Level-0 and Level-1 Data", "Produce Level-1 Data", "Update Level-1 Subsets", "Produce Level-2 HDF Data" and "Produce Level-3 HDF Data" presents the operator with a sub-menu.

The Produce Level-2 Data Menu allows the operator to select processing for a continuous day range or for a sample list of files.

The Produce Level-3 Data Menu provides selections to::

1. Merge Level-2 Orbital Files into a Daily File (necessary input for the Level 3 file generation program)
2. Produce CDTOMS Using Level-2 Daily File

The Produce Level-1 Calibration and Diagnostic Data Menu has selections to:

1. Run Intervention Program on Level-1 Data
2. Update Predictive ACF
3. Fill ACF Dataset with Fill Values
4. Dump ACF

The Update Zonal Means Menu has selections to :

1. Update Zonal Means Dataset
2. Dump a Selected Zonal Means File

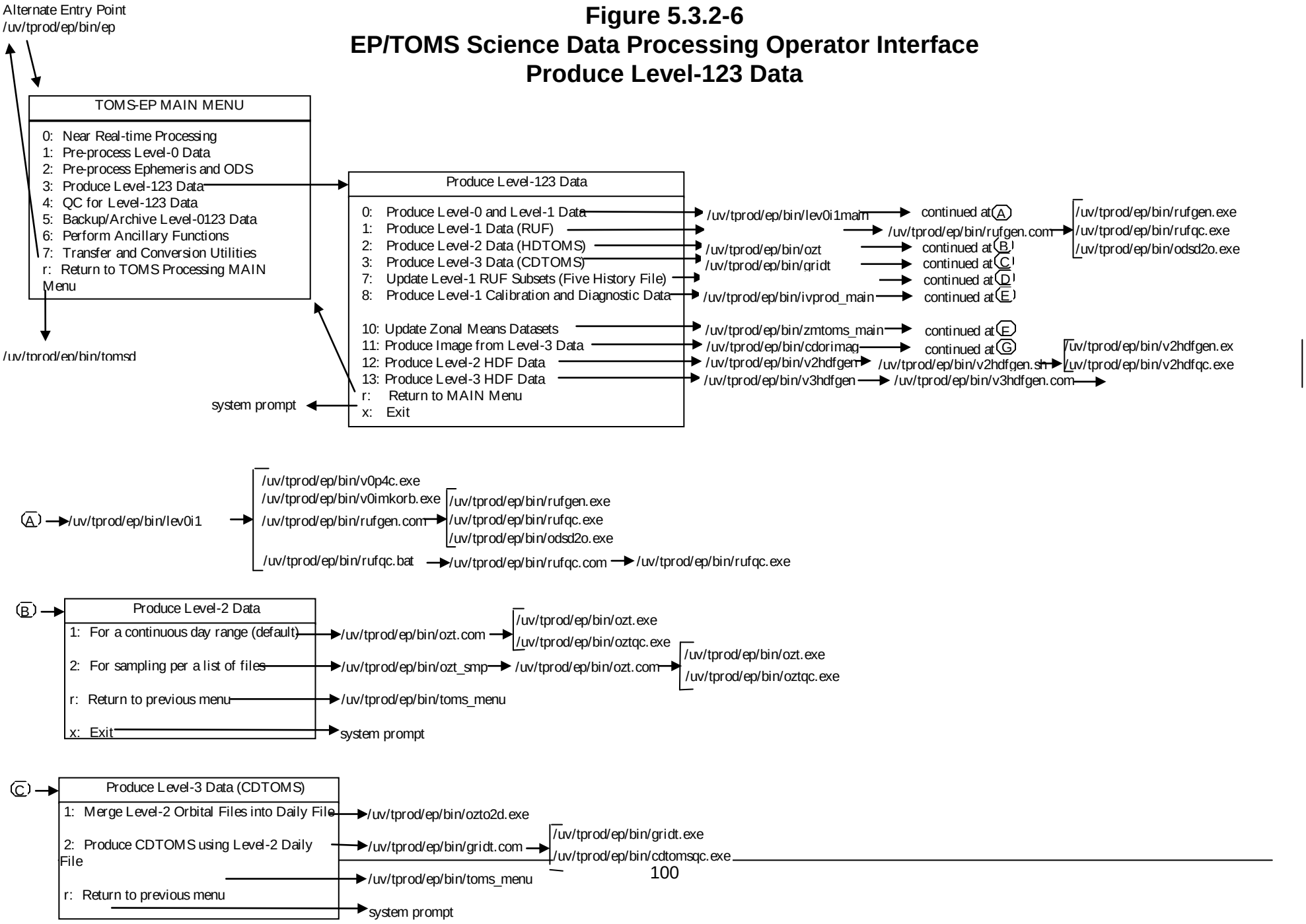
The Generate Image File from Level-3 Data has selections to produce:

1. Daily Cylindrical Map
2. Daily Polar Map
3. Daily AITOFF Map
4. Monthly Cylindrical Map

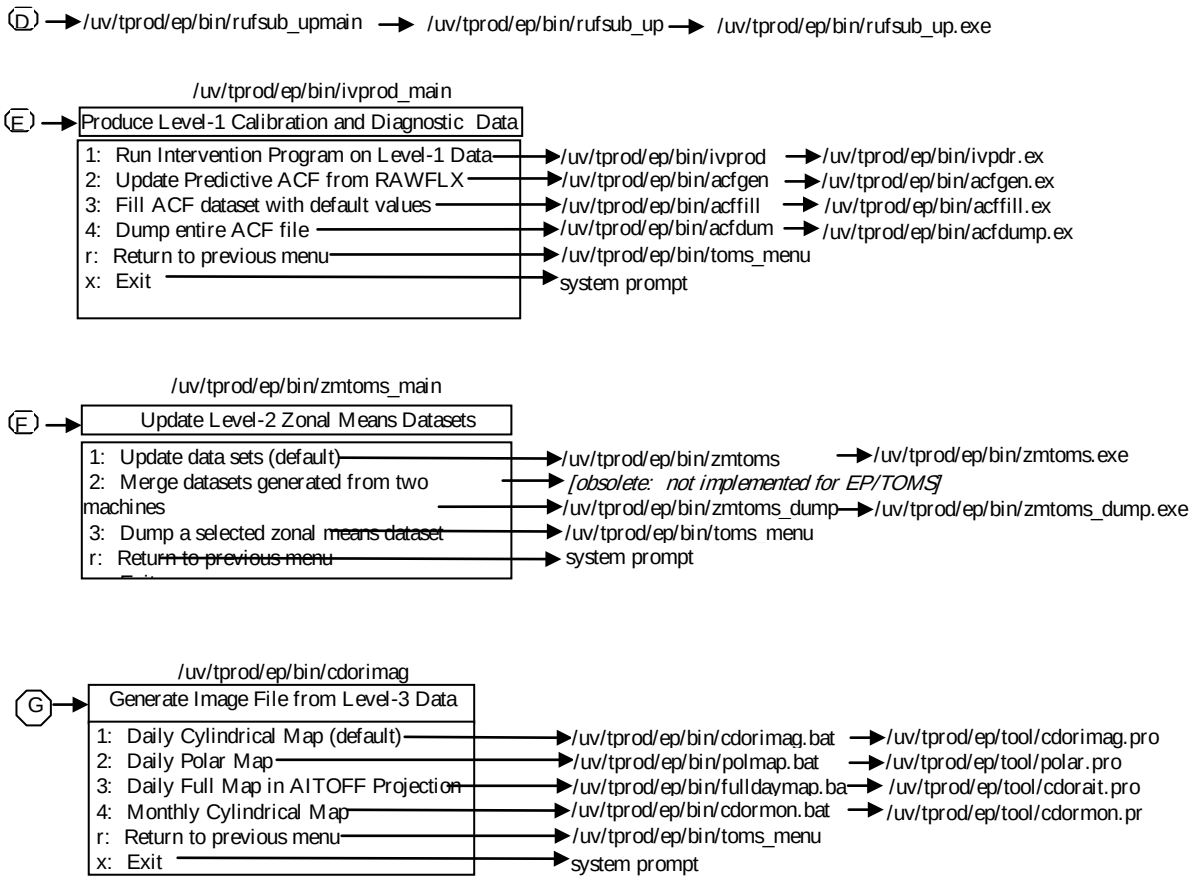
The FORTRAN, C, IDL, and shell executables invoked as the result of each selection are shown in Figure 5.3.2-6.

Descriptions of the *v0p4c, v0imkorb, rufgen, rufqc, odsd2o, ozt, oztqc, rufsub_up, ivpdr, acfgen, acffill, acfdump, zmtoms, zmtoms_dump, v2hdfgen,* and *v3hdfgen* programs are in Sections 5.1 and 5.2 and Appendices F, G, H, I, J, L, and M.

# Figure 5.3.2-6
# EP/TOMS Science Data Processing Operator Interface
# Produce Level-123 Data



## Figure 5.3.2-6 (continued from previous page)
## EP/TOMS Science Data Processing Operator Interface
## Produce Level-123 Data



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### QC Level-0123 Data

The "QC Level-0123 Data" selection allows the operator to perform quality checks on science data files. This selection causes the Data Validation Menu to be displayed. This menu has selections to:

1. QC Instrument Level-0 Data
2. QC Spacecraft Level-0 Data
3. QC Level-1 Data
4. QC Level-2 Data
5. QC Level-3 Data
6. QC Level-2 HDF Data
7. QC Level-3 HDF Data

The C and shell executables invoked as the result of each selection are shown in Figure 5.3.2-7.

Descriptions of the *v0iqc, v0sqc, rufqc, oztqc, cdtomsqc, v2hdfqc*, and *v3hdfqc* programs are in Sections 5.1 and 5.2 and Appendices F, H, J, and M.

### Backup/Archive Level-0123 Data

The "Backup/Archive Level-0123 Data" invokes shell executables, as shown in Figure 5.3.2-8, that are described in Sections 5.1 and 5.2.

### Perform Ancillary Functions

The "Perform Ancillary Functions" selection allows the operator to perform the following functions:

1. Dump Instrument Level-0 Data
2. Dump Spacecraft Level-0 or Subset Data
3. Dump Level-1 Data
4. Dump Level-1 Subsets
5. Dump Level-2 Data
6. Dump Terrain Height Data
7. Produce Daily Dataset from Calibration History File
8. Update Solar Eclipse Database
9. Dump Level-3 HDF Data

The "DUMP Level-1 Subsets" selection presents the operator with a sub-menu to allow selection of :

1. Calibration Subset
2. Instrument Status Subset
3. Housekeeping Subset
4. Local Equator Crossing Times
5. Processing Statistics

The FORTRAN, C and shell executables invoked as the result of each selection are shown in Figure 5.3.2-9.

**Figure 5.3.2-7**
**EP/TOMS Science Data Processing Menu Driven Operator Interface**
**QC for Level-0123 Data**

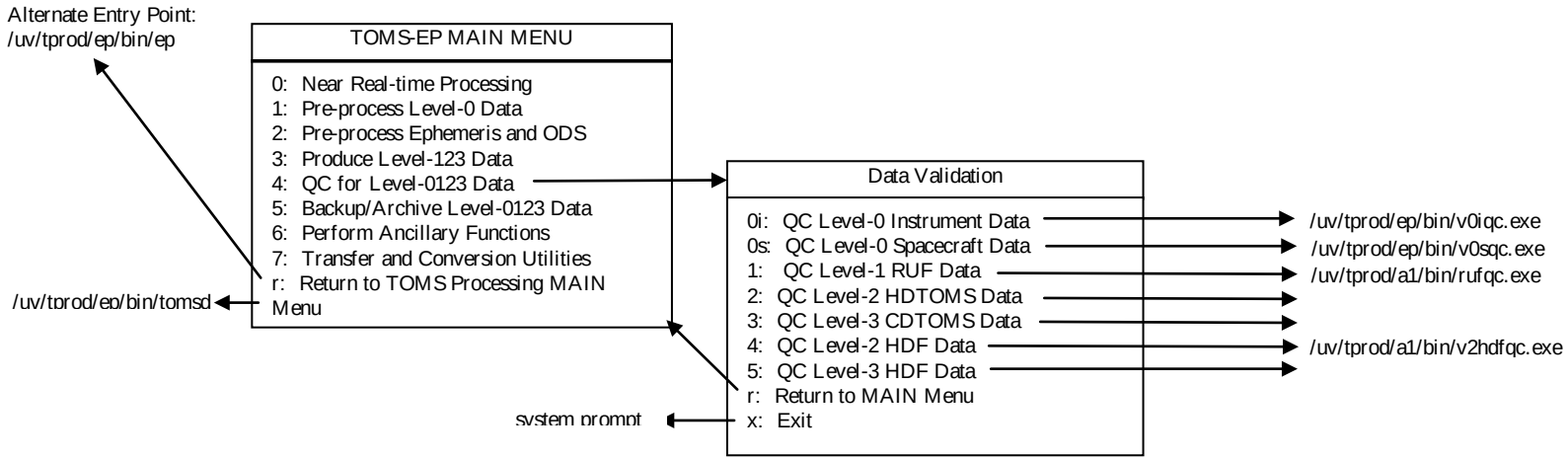
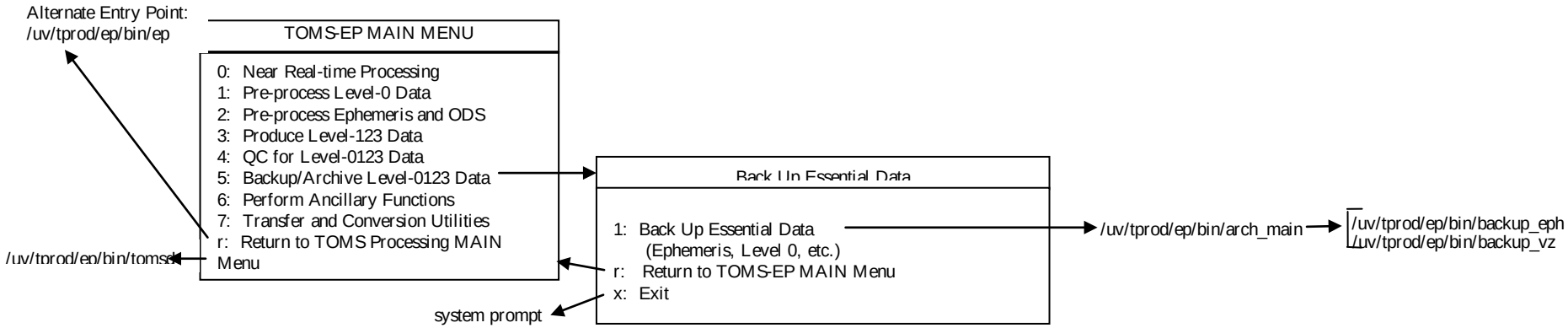
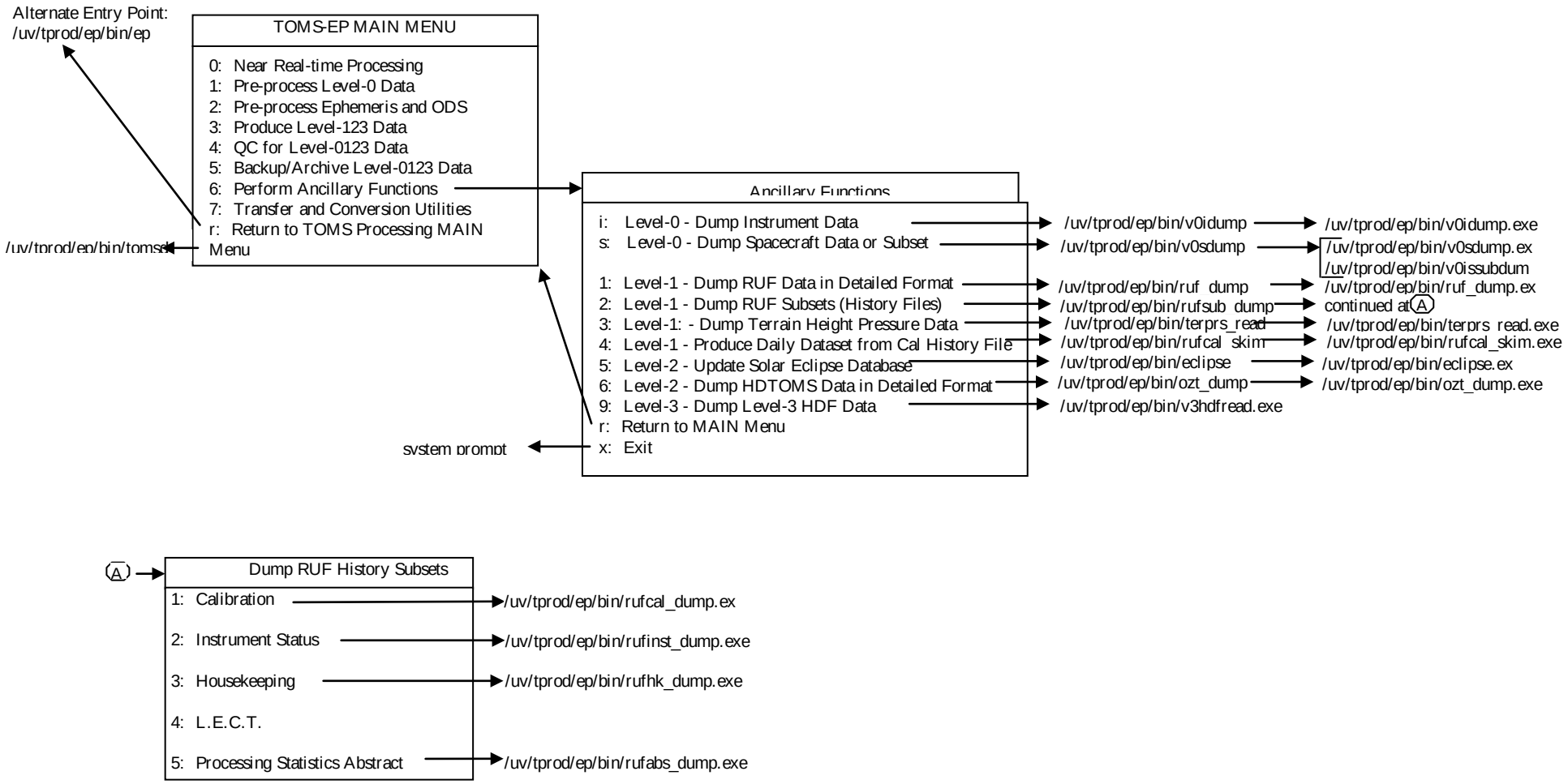


**Figure 5.3.2-8**
**EP/TOMS Science Data Processing Menu Driven Operator Interface**
**Archive/Recall Level-012 Data**



## Figure 5.3.2-9
## EP/TOMS Science Data Processing Menu Driven Operator Interface
## Ancillary Functions



Descriptions of the *v0idump, v0sdump, v0ssubdump, ruf_dump, terprs_read, rufcal_skim, eclipse, ozt_dump, v3hdfread, rufcal_dump, rufinst_dump, rufhk_dump*, and *rufabs_dump* programs are in Sections 5.1 and 5.2 and Appendices F, G, H, J, and M.

### Transfer and Conversion Utilities

The "Transfer and Conversion Utilities" selection is obsolete. In earlier versions of the TOMS science processing system utilities to convert data from IBM format to UNIX format were accessible through this selection.

# 6. Processing Procedures

The focus of this section is the operations of the EP/TOMS science data processing system. Information is provided concerning how processes are initiated and monitored and how resources and data are managed.

## 6.1 Process Initiation

The method for initiation of processes within the EP/TOMS science data processing system is controlled to ensure that only correct software is executed and that parameters passed to software are reasonably and conveniently specified. Process initiation for both data production processes and support processes are described in this section. Data production processes are those that lead to the generation of science data products. Support processes include those that perform functions that are useful in post-production product validation and system maintenance.

### 6.1.1 Production Process

EP/TOMS production software processes are initiated either automatically, as in the case of near real-time processing (see Section 5.3.1), or manually through an operator interface (see Section 5.3.2). Each method shares most software components but differ in the area of process control.

**Automatic Processing**

Section 5.3.1 presented the EP/TOMS software that is called via the Unix system 'cron' facility. In the case of product generation the presence of new files in the designated data delivery directories is~~are~~ recognized and the subsequent processing of those files is~~are~~ triggered by 'cron' daemons. Successful completion of each step in the automated process is required for the next step in the process to execute. The failure of one automated processing chain however does not impact the processing of the subsequent 'cron' initiated processes. Table 6.1.1-1 presents the schedule specified in the 'cron' table for each of the 'cron' processes listed in Section 5.3.1. As may be necessary this schedule, and the list of 'cron' jobs, may be modified through request to the production workstation’s System Administrator.

**Table 6.1.1-1**
**EP/TOMS 'cron' Initiated Process Schedule**

| cron | Function | Schedule |
|---|---|---|
| 1 | check for new Level 0 files and, if found, initiate near real-time processing of those files | every 5 minutes |
| 2 | check for new Spacecraft Ephemeris files and, if found, initiate near real-time processing of those files | every 10 minutes |
| 3 | backup new Instrument Level 0 files to 'mhatter' | everyday at 03:15 (local) |
| 4 | backup new Spacecraft Level 0 files to 'mhatter' | everyday at 03:30 (local) |
| 5 | backup new Spacecraft Ephemeris to 'mhatter' | every Saturday at 02:15 (local) |
| 6 | generate Calibration Products | every Wednesday at 15:30 (local) |
| 7 | backup processing system to 'wrabbit' | everyday at 05:00 & 15:00 (local) |
| 8 | update monthly set of daily ozone maps | everyday at 04:00 (local) |
| 9 | generate Monthly Level 3 Zonal Means | 2nd day of every month @ 6:00 |
| 10 | generate Level 3 Monthly Averages | 2nd day of every month @ 7:00 |

**Manual Processing**

An operator menu interface is used to initiate EP/TOMS science processing functions manually. This is necessary if the automated near real-time processing fails or in order to perform standard (HDF) product processing, redo processing, reprocessing, and special processing.

Section 5.3.2 described the operator menu interface from a software point of view. Throughout these software are user prompts to guide the operator through the menu hierarchy and to facilitate entry of processing parameters. These prompts are meant to be self-explanatory. Most prompts have default values that result if the operators replies with <ENTER>. The defaults are shown in parenthesis.

The operator menu interface has evolved from previous TOMS science processing activities. Some functionality is obsolete or has not been implemented for EP/TOMS. Selections of these functions result in an appropriate screen displayed message.

Access to the operator menu interface is limited to TOMS production personnel only. To enter the menu the operator enters the following at the Unix prompt (i.e. >):
**> /uv/tprod/toms**

### 6.1.2 Support Processes

The operator menu interface also provides convenient access to various support software (e.g. product QC, data display, file backup).

## 6.2 Production Monitoring/Reporting

Production monitoring includes monitoring the timeliness and data quality of all system inputs, the correctness and completion of all production processes, and the readiness of the computer environment and system configuration to perform subsequent processing.

A daily checklist is followed during near real-time processing to ensure that this monitoring process is complete. The steps in this monitoring process are as follows:

1) verify receipt of all expected data
2) verify processing of all data
3) verify distribution of near real-time data and images
4) verify data coverage
5) validate data products
6) verify availability of predictive s/c ephemeris
7) verify availability of updates to predictive calibration
8) verify solar eclipse database
9) verify system configuration
10) log & report anomalous system events

Other checklist items related specifically to computer resource and data management are discussed in Section 6.5 and 6.6 respectively.

Similar procedures are followed to monitor other processing scenarios.

**Verify receipt of all expected data**

Instrument Level 0, Spacecraft Level 0, and Spacecraft Ephemeris data are delivered to the EP/TOMS Science Data Processing System on a regular schedule. Presently Level 0 data are received twice per day; once in early morning and once around noon. Spacecraft Ephemeris files are received every Tuesday and Friday morning.

The operator reviews (via the Unix 'tail' command) the content of the Playback Inventory File (see Section 4.2) to verify receipt of Level 0 files. If expected files are not listed then the contents of /home/tmoc/reject are listed (Unix ls -l). If the expected file(s) are present in this reject directory then the file had failed QC and a detailed report would have been mailed to 'tomsprod@tparty.gsfc.nasa.gov' by the automated file ingest/QC process. Cases of missing or failed Level 0 files are resolved by contacting TMOC at 301-614-5338 or 301-286-6551 (fax 301-614-5271). If TMOC is unable to replace failed files it will be necessary to edit Level 0 inputs.

Receipt of spacecraft Ephemeris Files is verified by examining the /.../v1 and /.../nrt/v1 directories. The operator performs this verification by entering 'ls -l Dyymm*' or 'ls -l Pyymm*' respectively (appropriate substitutions are made for "yy" (2 digit year) and "mm" (2 digit month of year)). . If expected files are not listed then the contents of /home/fdf/reject are listed (Unix ls -l). If the expected file(s) are present in this reject directory then the file had failed QC and a detailed report would have been mailed to 'tomsprod@tparty.gsfc.nasa.gov' by the automated file ingest/QC process. Contact points to resolve cases of missing or failed FDF Spacecraft Ephemeris Files are maintained in */home/fdf/memo/phone.num*.

**Verify processing of all data**

Near real-time processing of each Instrument Level 0 file produces a detailed processing log. This processing log is e-mailed to the TOMS production userid. This log contains:

- overall processing summary
- Spacecraft Level 0 File QC report
- Instrument Level 0 File QC report
- report of overlap with previous Level 0 file
- identification of all input and output files
- Level 1 QC report for all new and updated orbits
- Level 2 processing summary for all new and updated orbits
- Level 3 QC report for new and updated files
- Level 3 image generation log

Processed orbits are verified against the orbit range reported for each playback in the Playback Inventory File.

The operator also verifies that each orbit has been processed to orbital Instrument Level 0, Level 1, and Level 2 files by examining Unix 'ls -l' output from the appropriate directories.

**Verify distribution of near real-time data**

Distribution of near real-time data is verified by:

1) accessing the TOMS Web Site and viewing the latest partial and complete global images
2) listing the content of NOAA's directory (i.e. /home/georges) and verifying that the latest files have been copied.

**Verify data coverage**

The Playback History File (see Section 4.2) contains detailed information concerning the content of each orbit received. Start times are compared to end times of previous orbits and mode counters are examined to determine the completeness of calibration sequences and daytime Earth view scan mode coverage. Any gaps are noted and traced back to Instrument Level 0 playback files. TMOC is notified of any gaps and may provide replacement data if it is possible to improve coverage. Permanent gaps in daytime Earth view coverage are logged in */uv/tprod/ep/v2/earthprobe_level2_data_coverage*.

**Validate data products**

Data product format is automatically verified through execution of standalone file QC software. File QC is executed immediately following product generation as a separate process in the production pipeline. In addition to file format QC several IDL tools are available to verify data content. These tools are listed in Section 5.2.1

**Verify availability of predictive s/c ephemeris**

A check is made each day to ensure that there is sufficient predictive spacecraft ephemeris to guarantee an uninterrupted near real-time processing at least through the next business day. This check is made by examining the header lines in the Orbit Data Set (see Section 4.2) and ensuring that this header is consistent with the file's content (i.e. last record is consistent with the end of the orbit span in the header.)

**Verify availability of updates to predictive calibration**

Updates to the predictive calibration (i.e. the Albedo Correction File) ares made automatically on a weekly basis (see Section 5.3.1). Verification of this update involves monitoring the automated process and ensuring that the ACF file has been updated (and that this update has been copied to the NOAA accessible directory).

**Verify solar eclipse database**

The Solar Eclipse File is updated, as needed based on information from the Astronomical Almanac. Verification is a manual process that is performed when updates are made. Should an anomaly be present in Level 2 output one of the initial steps in problem analysis is verification of correct specification of solar eclipse screening.

**Verify system configuration**

The TOMS Science Operations Manager monitors the system configuration on a routine basis. Initially a baseline configuration is established by executing Unix 'ls -l' on directories holding the EP/TOMS science processing system's auxiliary files, executable files, and source code files (see Section 1.1). Each week the current 'ls -l' listing for these directories is compared to the baseline. Differences in file date, file name, and file size are examined to ensure that any changes were the result of a legitimate software maintenance activity. In addition it is verified that permissions, owner, and group are unchanged.

**Log & report anomalous system events**

Each Thursday an "EP/TOMS Processing Report" is distributed via email[2]. This processing report documents anomalies in data flows and data processing and provides update status on any special processing or software maintenance activities.

## 6.3 Product Validation

Data product validation is routinely performed to identify software, algorithm, or calibration problems during near real-time processing. Suspected algorithm or calibration anomalies are immediately brought to the attention of science analysts. Suspected software problems result in the initiation of a software problem analysis activity.

Various tools, including file QC and IDL graphics applications, are available for use in data product validation. These tools are invoked via the operator menu interface (see Section 5.3.2). In addition file QC is performed within the processing chain as processes which automatically execute independently of the product generation software. Table 6.3-1 lists the IDL tools available through the operator menu interface to perform product validation. In general, each utilizes IDL widgets and/or character-based prompts for keyboard input. Each allows options for screen display or file (.GIF, .PS, etc.) output.

[2] TO: mcpeters@wrabbit.gsfc.nasa.gov
CC: batluck@tiffy.gsfc.nasa.gov, herman@tparty.gsfc.nasa.gov, emacie@pop500.gsfc.nasa.gov, rick.hudson@gsfc.nasa.gov, rjwhite@pop500.gsfc.nasa.gov, cgw@hoss.stx.com, erutkows@pop500.gsfc.nasa.gov, bguit@rattler.gsfc.nasa.gov, woodward@hoss.stx.com

## Table 6.3-1
## EP/TOMS Product Validation Tools

| Name | Function |
|---|---|
| aitstamp | produces Hammer-Aitoff equal area color global map from 2 consecutive native Level 3 (ASCII) files |
| cdclim | produces plot of 180 latitude band ozone or reflectivity statistics, from a native format Level 3 (ASCII) file, over a daily Nimbus-7/TOMS climatology [*useful for routine product validation*] |
| cdlat | plots ozone or reflectivity versus latitude for a specified longitude from a native format Level 3 (ASCII) file [*useful for spot checks & trouble shooting*] |
| cdlon | plots ozone or reflectivity versus longitude for a specified latitude from a native format Level 3 (ASCII) file [*useful for spot checks & trouble shooting*] |
| cdor | produces color contour plots of native format Level 3 (ASCII) ozone or reflectivity data over a set of cylindrical and orthogonal polar projection maps [previous internet image product] |
| cdormon | produces a monthly set of "postage stamp" color images of native format Level 3 (ASCII) ozone data. [*useful for future reference*] |
| dcov | plots number of scans of Level 2 data vs. time from native format Level 2 files [*useful to validate data coverage over a time period*] |
| ep_2day | produces Hammer-Aitoff equal area color global map from 2 consecutive native Level 3 (ASCII) files filled [*an internet image product*] |
| ep_pol | produces color contour plot of native format Level 3 (ASCII) ozone over a limited polar projection (70S to 90S) [*an internet image product*] |
| green | reflectivity plotted over Greenland base map. [*useful for validating Earth location*] |
| l3zmqc | produces total ozone vs. climatology QC plots (hemispheric, equatorial, and global) and SH min and ozone hole size plots |
| ozhis | plots min & max ozone, error ratios for algorithm flags 1, 2, 3, & 4, and error flag occurrence for each algorithm flag versus time from native format Level 2 files' Orbital Statistical Records [*useful for routine validation*] |
| snowice | plots global map of snow/ice probability for selected month. |
| zmtomslat | plots selected value from selected scene position from zonal means data versus latitude [*useful for data validation*] |
| zmtomsts | plots time series of selected value, scene, and latitude band [*useful for data validation over a time period*] |

## 6.4 Processing Problem Resolution

Problem reports are initiated whenever an anomaly is detected in a data input, during product validation, or in cases of software failure. The disposition of these reports varies depending on the source and nature of the anomaly.

### Data Input Anomaly

Typically cases of anomalies in input data files are reported to the data provider and replacement (corrected) files are usually provided in a reasonable time. The operator reports these anomalies, and provides update status concerning their resolution, to the production supervisor on a daily basis. These anomalies are included in the weekly processing report.

### Product Validation Anomaly

Anomalies detected during data product validation are immediately reported to the production supervisor. The production supervisor verifies that correct processing procedures were followed and directs a product redo if appropriate. Should the anomaly indicate a software defect then a software problem report is initiated. Should the anomaly be suspected to be due to an algorithm or calibration anomaly then the problem report, and supporting materials, is brought to the science staff for further analysis and recommendation or resolution.

### Software Failure

Failure of software to begin or complete execution will result in an immediate report to the production supervisor by the operator. The production supervisor will verify correct use of the software and if necessary will initiate a software problem report. If indicated the processing system will be modified to exclude execution of the failed software.

## 6.5 Computer Resource Management

Changes to the production system are copied, on a daily basis, to a backup workstation (currently *wrabbit.gsfc.nasa.gov*). This approach allows for a switch to the backup computer in the event that the primary computer fails. This switch can be made with minimal interruption to near real-time processing.

Also a check is made daily of available disk space using the Unix 'df' command. As necessary to ensure uninterrupted processing as least through the next business day files are backed up to DAT and space is released.

## 6.6 Data Management

In addition to manual backups of data to free disk space (see Section 5.3.2) backups of Level 0 data are performed automatically on a daily basis (see Section 5.3.1). Spacecraft Ephemeris files are also backed up automatically on a weekly basis. Standard (HDF) product datasets are archived at the GSFC DAAC.

# 7. Maintenance Procedures

This section describes the procedures used to maintain the EP/TOMS Science Data Processing System (including software, data, and system backups) and the procedures used to maintain this document. Procedures for maintaining system hardware and system level software (OS, compilers, COTS, etc.) are outside the scope of this document.

## 7.1 Software Maintenance

Software maintenance includes any change, addition, or deletion to any of the software inventory items listed in Table 1.1-1. The following are examples of recent software maintenance activities:

- implementation of the Version 7 ozone retrieval algorithm
- enhancement of level 3 file generation software to add a new Erythemal UV-B product
- change to the automated scheduling of ephemeris file ingest

The software contractor (SSAI) performs software maintenance under the direction of the NASA GSFC Code 916 Software Configuration Management Board (hereafter referred to as the "GSFC board"). This board consists of the GSFC TOMS Software Manager and the TOMS instruments' Principal Investigators. The SSAI Software Manager is the contractor's contact point with the GSFC board. Table 7.1-1 lists contact information for these individuals as of the date of this document.

Each step in the software maintenance process requires close coordination between the GSFC board and the software contractor. Documentation is produced at each step to provide an audit trail of software changes. Figure 7.1-1 illustrates the software maintenance process. The software maintenance process consists of 3 steps (initiation, implementation, and installation) and the review/approval of each step.

### 7.1.1 Initiation of a Software Maintenance Activity

A software maintenance activity may be initiated by a GSFC board generated Change Order or by a request from the software contractor to implement a change. Either can be used to initiate a change to enhance, correct, or otherwise modify the science processing system. A Problem Report may or may not be associated with a change. Problem Reports can originate from data processing at GSFC or NOAA/NESDIS or from data analysis by SSAI ~~STX~~, a member of the TOMS Science Team, or some other data user.

**Change Order**

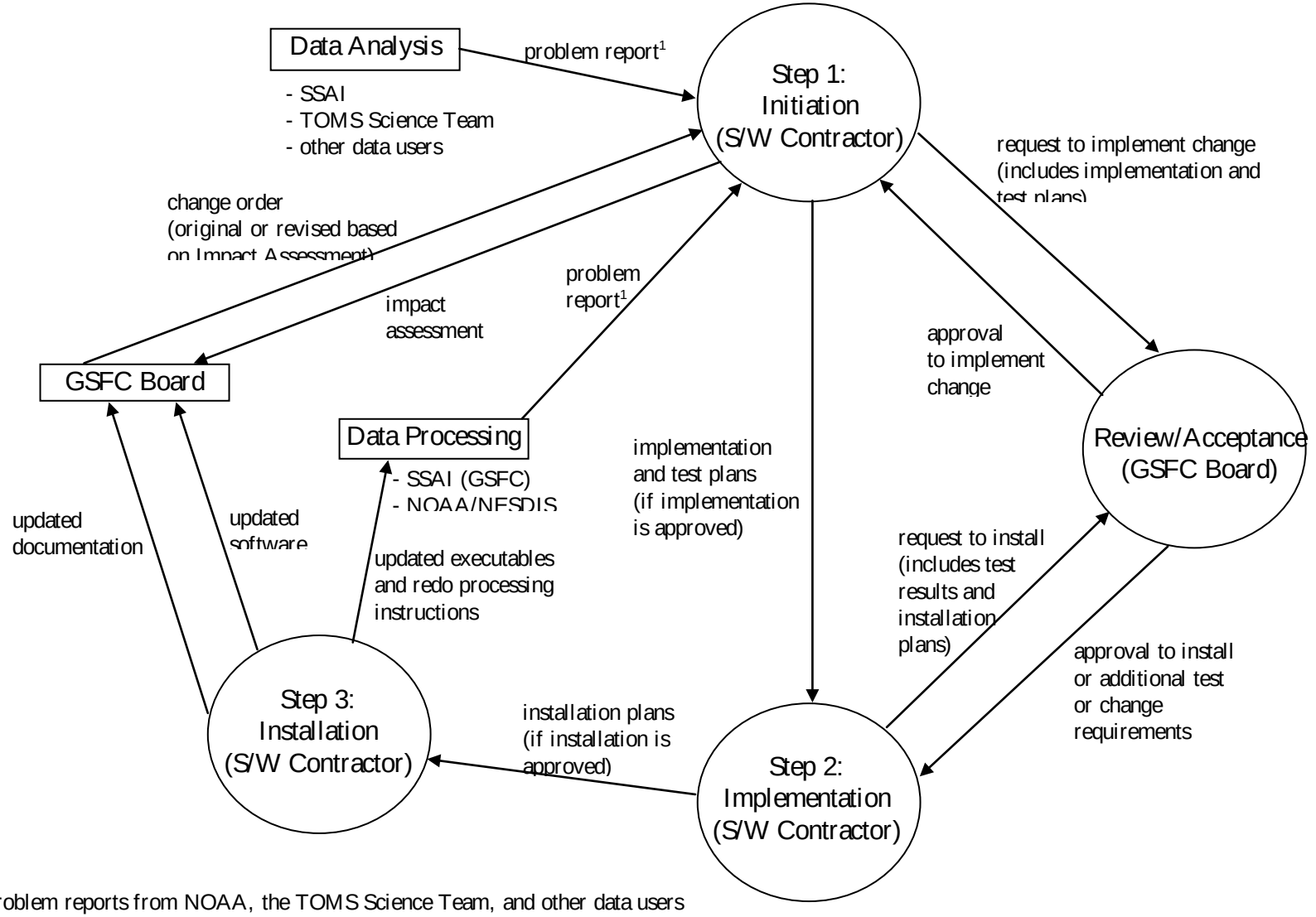
A Change Order is a statement of changes to be made to the EP/TOMS Science Processing System. The GSFC board originates Change Orders and sends them to the software maintenance contractor for analysis and/or implementation. Change requirements may originate within the GSFC board or may be routed through the GSFC board from some external source.

**Table 7.1-1**
**TOMS Software Maintenance Contact Points**

| NASA GSFC Code 916 Software Configuration Management Board | TOMS Software Contractor (SSAISTX Corporation) |
|---|---|
| Ms. Georgiann Batluck<br>GSFC TOMS Software Manager<br>E-mail: batluck@tiffy.gsfc.nasa.gov<br>Phone: 301-614-6044286-8321<br>FAX: 301-286-1754<br><br>Dr. Jay Herman<br>Meteor-3/TOMS Principal Investigator<br>E-mail: herman@tparty.gsfc.nasa.gov<br>Phone: 301-614-6039286-7821<br>FAX: 301-286-1754<br><br>Dr. Richard McPeters<br>Nimbus-7/TOMS & EP/TOMS Principal Investigator<br>E-mail: mcpeters@wrabbit.gsfc.nasa.gov<br>Phone: 301-614-6038286-3832<br>FAX: 301-286-1754<br><br>Dr. Arlin Krueger<br>ADEOS/TOMS Principal Investigator<br>E-mail: krueger@chapman.gsfc.nasa.gov<br>Phone: 301-614-5554286-6358<br>FAX: 301-286-1754 | Mr. David Haffner<br>TOMS Software Liaison<br>E-mail: david_haffner@ssaihq.com<br>Phone: 301-867-2175<br>FAX: 301-867-2151 |

**Figure 7.1-1**

**Software Change Process**




[1]problem reports from NOAA, the TOMS Science Team, and other data users are typically routed through GSFC board members to the software contractor

The Change Order may or may not be accompanied by coded algorithms. An analysis by the contractor is typically required prior to implementation to assess the affect on software, computer resources, and schedules. If required impact assessments are delivered to the GSFC board for review prior to proceeding with implementation. A modified Change Order may be issued by the GSFC board based on the impact assessment.

Change Orders and impact assessments must be in writing or e-mail. A software change history folder is started by the software contractor upon receipt of a Change Order and is maintained throughout the software life cycle. This folder is subsequently updated to include any additional documents relevant to the analysis or implementation of the Change Order.

**Change Request**

The software contractor may initiate requests to implement changes. Included in this request is an explanation of what should be changed, why it should be changed, and, when appropriate, the affect on computer resources, schedules, and manpower. The request may also suggest a priority for implementation. Test plans are provided and reviewed as part of the change request process. The GSFC board may:

1) accept the change and approve its implementation
2) modify the change and initiate a Change Order
3) defer action until a later time
4) disapprove the change

Requests to implement changes must be in writing or e-mail. A software change history folder is started whenever a request is sent. This folder is subsequently updated to include additional documents relevant to this request including GSFC board response and any analysis or software change. Requests may be for enhancements identified by the software contractor or may be the result of software related problems.

**Problem Report Generated During Data Processing**

Problem Reports are initiated whenever an anomaly is detected in a data input, during product validation, or in cases of software failure. The disposition of a Problem Report depends on the source and nature of the anomaly.

Typically cases of anomalies in input data files are reported to the data provider and replacement (corrected) files are usually provided in a reasonable time. The contractor's data processing analyst reports these anomalies and provides update status concerning their resolution to the SSAI Software Manager on a daily basis. No software change results from these types of problem reports. These anomalies are included in the contractor's weekly processing report.

Anomalies detected during data product validation are also reported to the SSAI ~~STX~~ Software Manager. The Software Manager verifies that correct processing procedures were followed and directs a product redo and analysis, if necessary. The change request process is initiated if the anomaly indicates a software defect. Should the anomaly be suspected to be due to an algorithm or calibration anomaly then the problem report and supporting materials are brought to the appropriate TOMS Principal Investigator(s) for further analysis and recommendation or resolution.

Problem analysis may indicate the need for a software change. If so the Problem Report is included in the request to implement change that is sent to the GSFC board. In this case the change request includes an explanation of what code caused the problem and what changes are necessary to fix the problem. An assessment of data affected by the problem and recommended plans for replacing affected data after the software modification is complete are also part of the change request.

Problem Reports and requests to implement changes are always sent to the GSFC board in writing or e-mail. A software change history folder is started whenever a change request is sent. This folder is subsequently updated to include additional documents relevant to this request including GSFC board response and any analysis or software change.

Problem Report Generated During Data Analysis

In the event that a problem is detected or suspected during data analysis a Problem Report is initiated. The Problem Report may be sent to the GSFC board or directly to the software contractor.

The data analyst's Problem Report must be in writing or e-mail and should include:

- product name, data coverage, generation date, etc. (a copy of the data product header is desirable)
- data source (GSFC DAAC, 916 cluster [give machine name and file name with full path], colleague, etc.)
- a detailed description of the problem
- evidence (data dump, plot, etc.)
- science impact
- suggestions concerning problem resolution or work arounds (optional)

If the Problem Report is sent to the GSFC board (and the board determines that it should be investigated) then it is forwarded to the software contractor (i.e. the SSAI ~~STX~~ Software Manager).

Upon receipt of a data analyst's Problem Report the SSAI ~~STX~~ Software Manager verifies the problem, initiates problem analysis activities, and coordinates communication among relevant parties. Problem analysis is complete when the problem is well understood and all relevant software, procedures, auxiliary data, and/or documentation change requirements are determined. A request to implement changes is then sent to the GSFC board. All documents supporting the request are kept in a permanent software change history folder.

The originator of the Problem Report is kept informed throughout the problem analysis. Any replacement files that are generated in response to a Problem Report are advertised via the README files stored in the data directories and, when appropriate, on the TOMS Web Site.

### 7.1.2 Software Implementation

Software implementation refers to the processes that occur from the time that a change is approved until the time that the change or addition is ready for installation in the TOMS processing system. Software implementation includes design, coding, and testing. The software implementation process is the same regardless of how the software change was initiated.

A written (or e-mail) approval to implement the change must be received prior to any software change implementation. A Change Order may include this approval. Implementations of Change Orders proceed on a highest priority first schedule. The GSFC board specifies priorities. When implementation approval is received the detailed design, coding, and testing of the new or modified software begins. Implementation is performed in the contractor's development environment using a copy of the baseline software that is retrieved from the controlled software library at GSFC. The contractor's Software Manager works closely with maintenance programmers to ensure that the implementation is correct, properly documented, and thoroughly tested both in the contractor's development environment and in GSFC's processing environment.

The nature of the change will guide the scope of acceptance testing required. In most cases it will be sufficient to use a sampling of historical data to test a change. In some cases a more exhaustive testing will be necessary. Testing of anomaly cases may be indicated. In any case the testing scenario will be tailored to the modification so that resources are not wasted while ensuring that modified software will perform correctly and reliably. The GSFC board may specify specific test scenarios.

All test results are made available on GSFC computers for board review prior to proceeding with the installation. Test and sample files are placed in a subdirectory under */uv/tprod/ep/tmp/test/*. The subdirectory is named in accordance with the program and version number (i.e. *gridt_2.7/* would contain the test files generated by the candidate Level 3 ASCII File Generation (*gridt*) program identified as version 2.7).

A summary of the implementation and pre-acceptance test results are submitted to the GSFC board prior to installation. The GSFC board may:

1) accept the software implementation and approve it for installation
2) request additional changes or additional testing
3) disapprove the implementation entirely

A written (or e-mail) notification that approves the implementation and the installation plan must be received by the software contractor prior to installation.

Prior to submitting a request for installation approval the new or modified software is delivered to the GSFC software library in a temporary version specific directory for GSFC's review. For example, when the implementation of the Version 2.7 gridt program was complete the */uv/tprod/ep/src/v3/gridt/Version_2.7/* directory was established on the 'tparty' workstation and all new or changed program modules were placed there. A README and a modified makefile was also placed in this directory. These files remain in the version specific directory until the end of the installation process.

### 7.1.3 Software Installation

Once the installation is approved the software contractor:

- modifies process control scripts as needed
- moves the new executable into */uv/tprod/ep/bin/*
- moves obsolete files into a newly created version specific subdirectory (*/uv/tprod/ep/src/v3/gridt/Version_2.6/* in the previous example)
- writes a README file for the new subdirectory

- moves new or changed modules, prolog, and makefile into the current version program subdirectory (i.e. from */uv/tprod/ep/src/v3/gridt/Version_2.7/* to */uv/tprod/ep/src/v3/gridt/* in the previous example)
- sends an installation complete notification to the GSFC board
- prepares and delivers updates to this programmer's guide (see Section 7.4)
- closes and files the software change history folder

## 7.2 Data Maintenance

Data maintenance includes the monitoring of disk space and the maintenance of permanent data libraries as well as the maintenance of the various auxiliary data required for data processing.

### Disk Space and Data Libraries

A daily check is made of available disk space on the primary and backup processing workstations (i.e. '*tparty*' and '*wrabbit*') using the Unix 'df' command., Files are backed up to DAT and space is released as needed to ensure uninterrupted processing as least through the next business day.

In addition to these manual backups instrument level 0 playback data are automatically copied to permanent online storage locations on a daily basis (see Section 5.3.1). Spacecraft Ephemeris files are automatically copied to their permanent storage locations on a weekly basis.

The present locations for the source data files and for the near real-time EP/TOMS science data product files are shown in Table 7.2-1. This table also identifies the short-term and permanent backup locations for these files.

### Auxiliary Data

From time to time it may be necessary to update an auxiliary data file (see Section 4.2) to add, replace, or delete content. A recent example is a correction that was made to the overpass site list. Auxiliary file updates flow from either a Problem Report or a Change Order. Any changes to auxiliary data are carefully tested and are fully documented in the same manner as a software change (see Section 7.1). All software components used to read, write, or display the affected auxiliary data are updated as needed following established software change procedures. Process control software is updated as a final step to complete the implementation. GSFC board approval (written or e-mail) is required prior to installation of any auxiliary file updates.

## Table 7.2-1
## EP/TOMS Data Storage

| Data Type | Online Storage | Short-term Backup | Backup Storage |
|---|---|---|---|
| instrument level 0 (playback) | 'mhatter' | 'wrabbit' (past 7 days) | DAT |
| orbital instrument level 0 | 'tparty' (until moved to DAT) | 'wrabbit' (past 77 days) | DAT |
| spacecraft level 0 | 'tparty' (until moved to DAT) | 'wrabbit' (past 4 days) | DAT |
| spacecraft subset | 'mhatter' | noneе | |
| spacecraft ephemeris | 'mhatter' | none | DAT (definitive) |
| level 1 raw units files | 'mhatter' (1996-1997) 'isnark' (1998) | 'wrabbit' (past 144 days) | DAT |
| level 2 (native) files | 'mhatter' (1996-1997) 'tparty' (1998) | 'wrabbit' (past 7 days) | none |
| daily level 2 files | 'isnark' | 'wrabbit' (past 7 days) | 'mhatter' |
| level 2 standard product files | 'mhatter' | none | DLT |
| zonal means | 'tparty' | 'wrabbit' none | 'wrabbit |
| level 3 ASCII files (ozone) | 'tparty' & 'jwocky' | 'wrabbit' (past 7 days) | none |
| level 3 ASCII files (reflectivity) | 'tparty' | 'wrabbit' (past 7 days) | none |
| level 3 ASCII files (aerosol) | 'tparty' | 'wrabbit' (past 7 days) | none |
| level 3 ASCII files (erythemal UV) | 'tparty' | 'wrabbit' (past 7 days) | none |
| level 3 standard product files | 'mhatter' | none | none |

*NOTE: all data types are initially stored on 'tparty' then moved or copied to permanent online, short-term backup and permanent backup storage locations

## 7.3 System Backup

Critical system components are backed up on a regular basis. Offline (tape) backups are made of Level 0 data and definitive spacecraft ephemeris data. These source data are also maintained online at GSFC. Having duplicate sets of source data ensures that any higher level product can be regenerated if needed. Regeneration capability is assured because duplicate sets of software and auxiliary files are maintained on GSFC's '*tparty*' and '*wrabbit*' workstations.

Changes to the production system software are copied, on a daily basis, to the backup processing workstation (currently *wrabbit.gsfc.nasa.gov*). This approach permits a switch to the backup computer in the event that the primary computer fails. This switch can be made with minimal interruption to near real-time processing.

## 7.4 Documentation Maintenance

Documentation maintenance is an ongoing responsibility of the software contractor. Documentation maintenance is an integral part of software maintenance. In general each software modification will result is some documentation change. In general dDocumentation changes are accumulated and delivered quarterly to the GSFC board as part of the software installation process.

Future changes to this EP/TOMS Programmer's Guide will be required to:

- document changes made to processing software
- document new or modified data (input, product, or intermediate)
- show changes in file system configuration
- correct documentation errors or omissions
- show changes in process control
- enhance content or format (e.g. expand document scope or depth of detail)
- update other information

These changes will be tracked through the revision history that appears as the first page(s) of this and subsequent versions of this document.

Version numbers of subsequent issues will be determined based on the extent of the changes made. In cases of relatively minor changes to content or format the numeric to the right of the decimal point will be incremented (e.g. 1.0, 1.1, ..., 1,9, 1.10,...). If major changes are made (e.g. complete rewrites of sections, addition of major subsystems, etc.) then the part of the version number to the left of the decimal point will be incremented.

New or modified pages will be identified in two ways. The first will be a list of new and changed pages that will accompany the issue of a new version. The second is through the use of vertical bars in the margin next to the change or addition. These marks will only show change from the previous version (i.e. they will not be cumulative).

Documentation changes will typically be distributed on a "changed pages only" basis. If new pages are added the preceding page number plus an alphabetic character(s) will be used (e.g.

3, 3a, 3b, …, 3z, 3aa, …, 3az, 3ba, 3bb, …).